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POWER GENERATION
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VOLUME 83 NUMBER 6

POWER

N. O. WYNKOOP, *Publisher* — PHILIP W. SWAIN, *Editor*

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JUNE, 1939

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Publication office: 99-129 North Broadway, Albany, N. Y.
Editorial & Executive Offices: 330 West 42nd St., New York, N. Y.

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CLEVELAND, 1510 Hanna Bldg. — LONDON, Aldwych House, Aldwych, London, W C.2

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POWER articles are currently indexed in both the Industrial Arts and the Engineering Indexes, available at public libraries. Also every year POWER issues an annual index of its own. Cable Address: "McGraw-Hill, N. Y."

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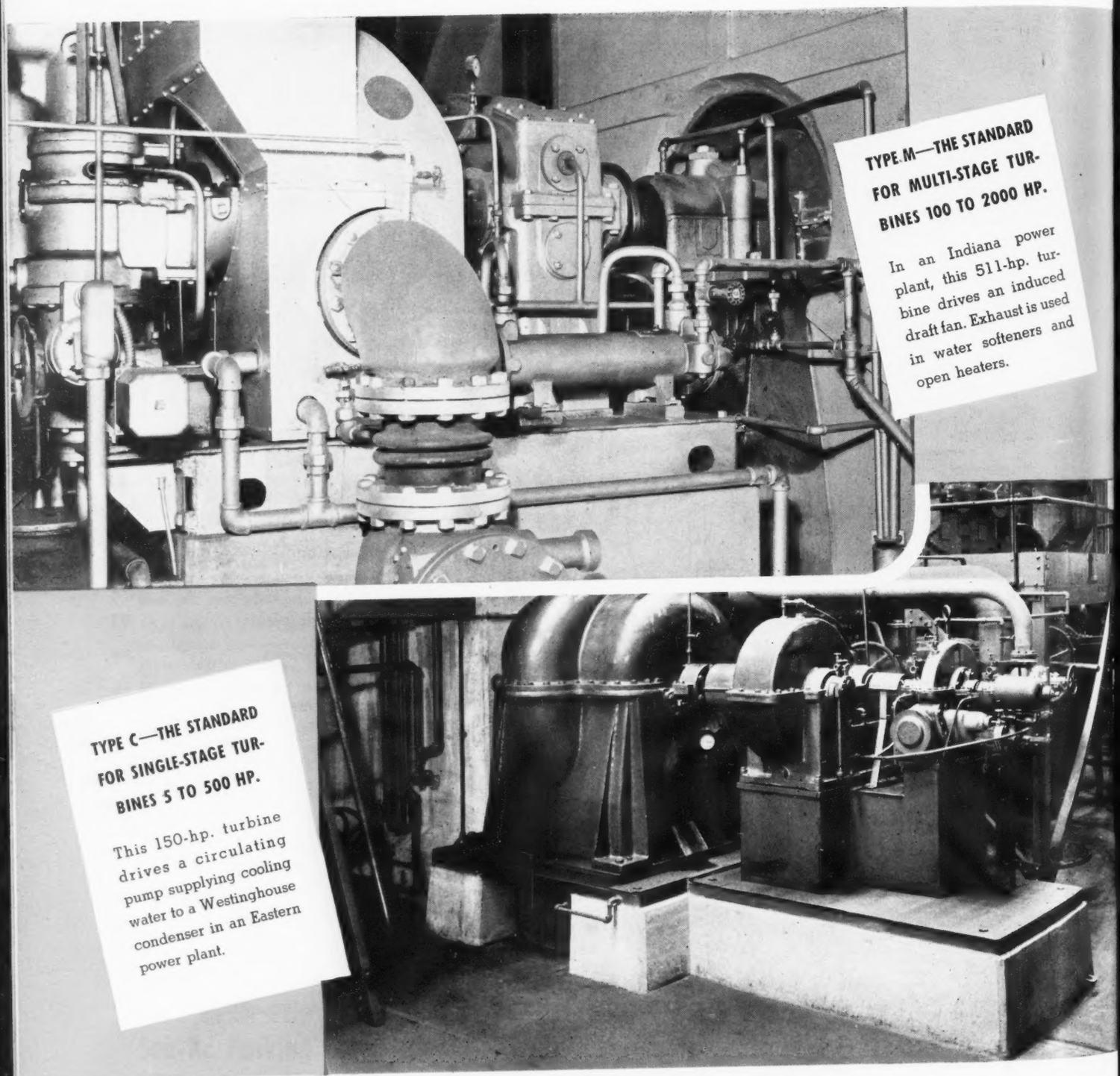

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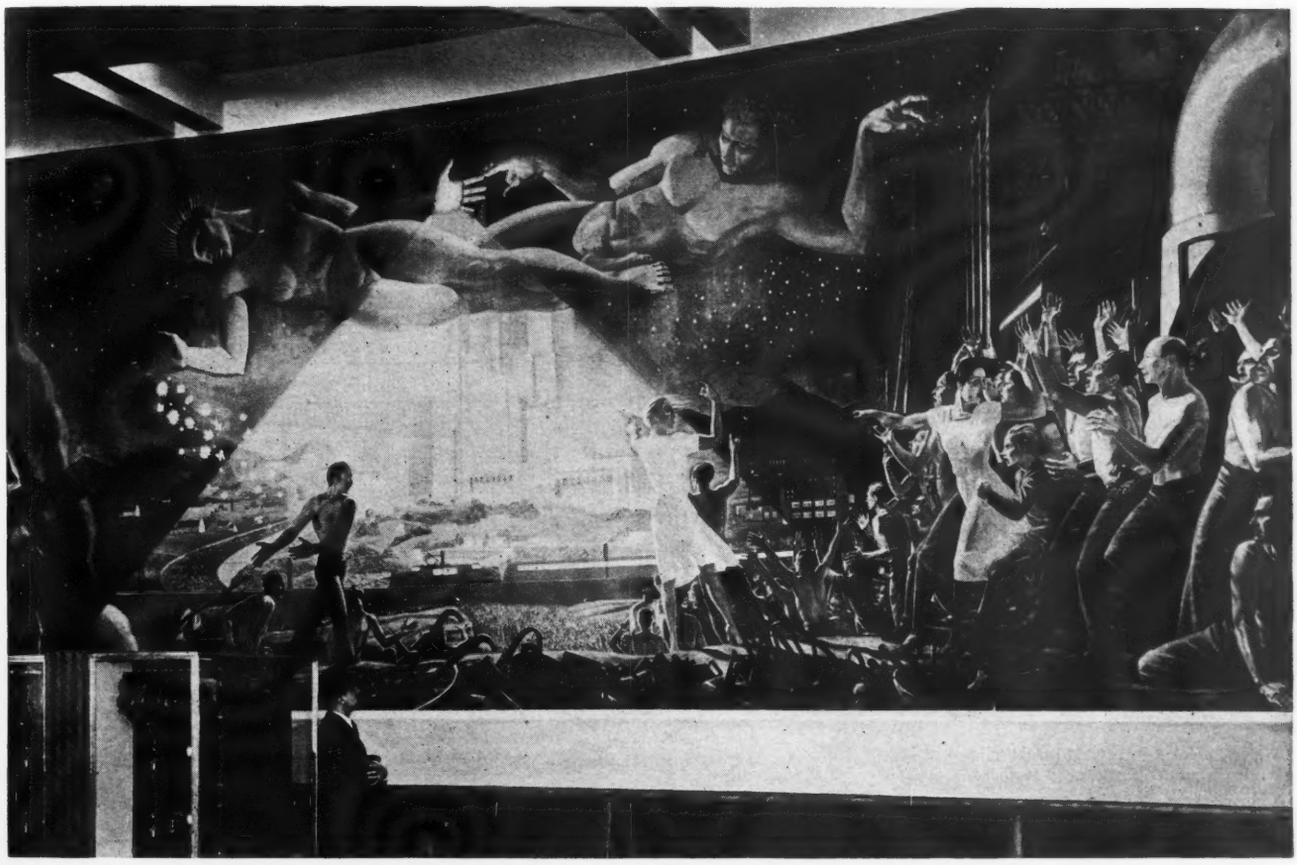


Rockwell Kent's gigantic mural depicts mankind freed by power

MAN VIEWS POWER

"World of Tomorrow" is the theme of the New York World's Fair. Yet this, the most spectacular exhibition our planet has yet seen, is truly a world of *today*. This wonderland was built on a swamp by today's engineers, with today's materials. All its parts are moved, controlled and illuminated by today's power. No object, force or idea is there, other than those already in man's service. We call it the World of Tomorrow, because we won't face the fact that we have it now.

No man can know what the world of tomorrow will be like. All we can do is write a minimum specification of what it might be—the best things we now have and know, rightly coordinated, intelligently controlled, bountifully shared.

Through this best world of today, the conceivable whole world of tomorrow, runs the thread of power, part of the very weave.

On page 85 we take Engineer Jones, footloose and carefree, around the Fair to marvel and wisecrack. That approach is as good as any. Figuratively speaking, Jones may come to scoff, but he must stay to pray that mankind will learn to use what it already has—the materials, forces and ideas already developed.

Go to the Fair. See what you see. Then ask yourself, in the name of common sense, whether it's not time for America to wake up and shake herself out of a bad dream—time to open the window, take a breath of fresh air and a look at the morning sun.

Now Gas Turbines that Work

Gas turbines have supplied power for supercharging Velox boilers and diesel engines for several years. Recent developments on eleven byproduct power installations in this country indicate their application to direct power generation

By S A TUCKER
Associate Editor

THE IDEA of getting useful power from the direct expansion of fuel-combustion products is far from new, but heretofore the gas-expansion cycle has been practical only within the cylinders of reciprocating engines. The latter include, of course, all internal-combustion engines whether the fuel is gasoline, fuel oil or any of several fuel gases.

The gas turbine as a primary power unit, however, has been little more than an inventors' dream until recently. It offers advantages parallel to those of a steam turbine over a steam engine in that direct conversion of fuel energy to power on a rotating shaft is possible, eliminating the reciprocating motion, difficult problems of fuel injection and cylinder lubrication, and *all need for cooling water*. It is the latter and certain characteristics of use in chemical process that have provided the incentive for development and offer best possibilities for future application.

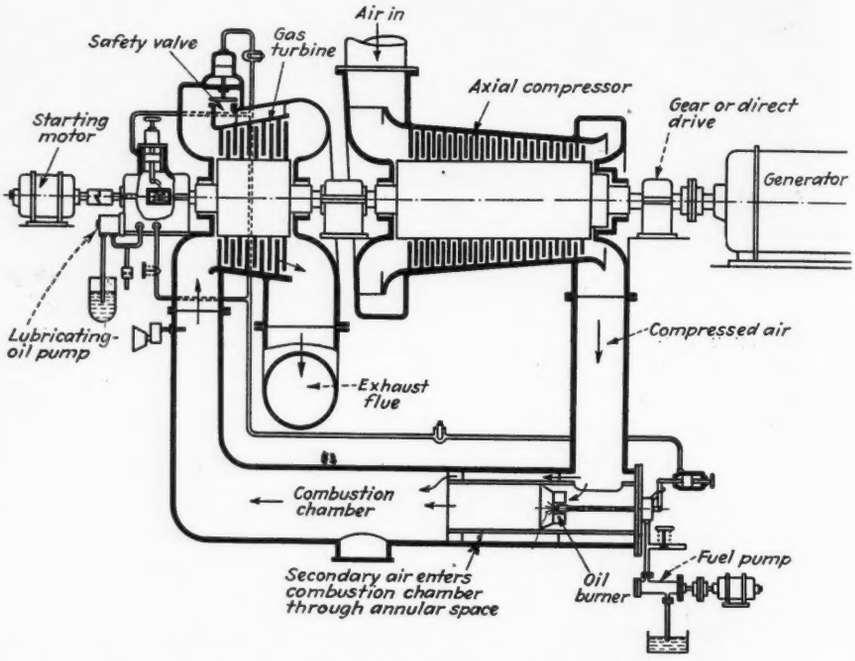


Fig. 1—The continuous-combustion gas-turbine unit includes a high-efficiency air compressor, a combustion chamber and a multi-stage reaction turbine

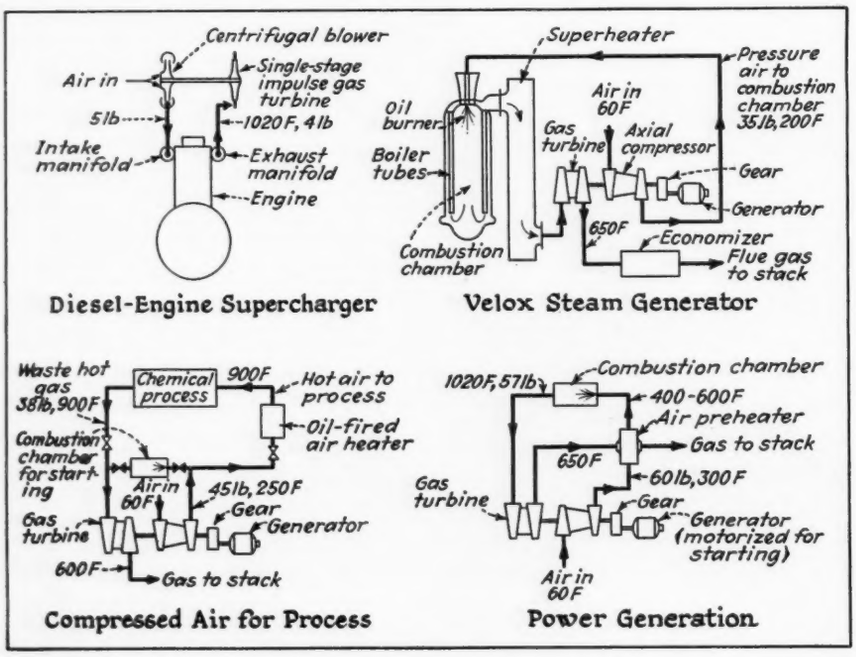


Fig. 2—Four gas-turbine hookups

It must be remembered that the gas turbine is still in an early stage of development. While gas-turbine and compressor sets have operated as an auxiliary to Velox boilers since 1930 and two units have each served oil refiners for two years or more, the potential applications have only begun to be investigated. At the present time thirteen units are on order or in operation and another high-speed European unit is being tested experimentally.

No one expects that gas turbines will immediately replace steam turbines, steam engines or internal-combustion engines as primary producers of power. First practical use has been as auxiliary to the pressure-combustion steam boiler (Velox—POWER, April 12, 1932) and in the Houdry oil-cracking process (*Oil and Gas Journal*—Nov. 24, 1938

and *Chemical & Metallurgical Engineering*, April, 1939). The 100-kw Jendrassik experimental turbine was described in *Engineering*, London (Feb. 17, 1939). The most complete publication of technical detail and a survey of possible applications is contained in a paper presented before the British Institution of Mechanical Engineers by Dr Adolph Meyer*, a thorough abstract of which appeared in *Engineering* for March 3, 1939. The author is indebted to Dr Meyer and to the Brown Boveri Co for much of the technical detail of this article.

What is a Gas Turbine?

The simplest form of gas-turbine compressor set is shown in Fig. 1, complete with fuel-burning chamber and generator. Operation of this unit is continuous. Air from room or outdoors is compressed to 30–50 lb, mixed with oil fuel and burned in the combustion chamber. The products of combustion, including excess air added to keep gas temperature down to a predetermined limit, expands through the turbine blading to exhaust flue or stack. About 75% of the output of the turbine goes to drive the compressor, the remainder is available for electric generation.

This cycle is distinct from the earlier "explosion" gas turbine (Holzwarth) in which intermittent operation of combustion chambers helped compress the charge and a valve arrangement was required to admit gas to the turbine blading.

In the combustion gas-turbine cycle, there is no boiler, no feed pump, no condenser or cooling water. For the simplest plant, the only auxiliaries required are fuel pump and a means of starting. For the latter, a small motor brings the turbine up to about quarter speed. At 1000-F gas temperature, an over-all thermal efficiency of 15–18% is possible (19,000 to 23,000 Btu per kwhr at the generator coupling). Considerably better efficiency up to 23% (15,000 Btu) can be obtained for direct power production by air preheat and by a 2-shaft arrangement.

Dr Meyer traces the history of gas-turbine development back to 1791. First known practical trials, however, were made in 1900–1904 on the Stolze hot-air turbine. This machine was the first to employ a multi-stage axial compressor. The latter was unsuccessful due to the limited knowledge then available of aerodynamics.

The gas turbine of Armangaud Lemale injected water into the combustion space to limit gas temperature to 1030 F. It was served by a 25-stage Brown-Boveri turbo-compressor developing 45–lb pressure. While the turbine could not be considered a success because no net output of power was obtained, the experience gained enabled the Societe des Turbo-Moteurs to improve the performance of torpedoes by heating the compressed air as it passed from storage chamber to propeller-driving mechanism.

The Holzwarth turbine of 1905 utilized the intermittent explosion of fuel charges in separate combustion chambers under the control of a valve arrangement. This required making some steam for driving the air compressor by a condensing turbine with resultant complication in auxiliary equipment. Several such units were built and tested between 1906 and 1928 by Korting, Brown-Boveri and Thyssen. One of these, operating on a 2-cycle, 2-chamber arrangement, has been in service using blast-furnace gas since 1933 in a German steel plant. A 5000-hp turbine of this type is now being built by Brown-Boveri at Mannheim, Germany.

The work on the explosion gas turbine contributed to development of the Velox boiler designed for pressure combustion. The first Velox-boiler turbine-compressor sets were designed on the explosion principle but later units employ continuous firing. In these boilers, pressure in the combustion chamber is kept between 20 and 40 lb, a high gas velocity is maintained across the steam-generating surfaces and power for the compressor is supplied by the expansion of the flue gas through a gas turbine.

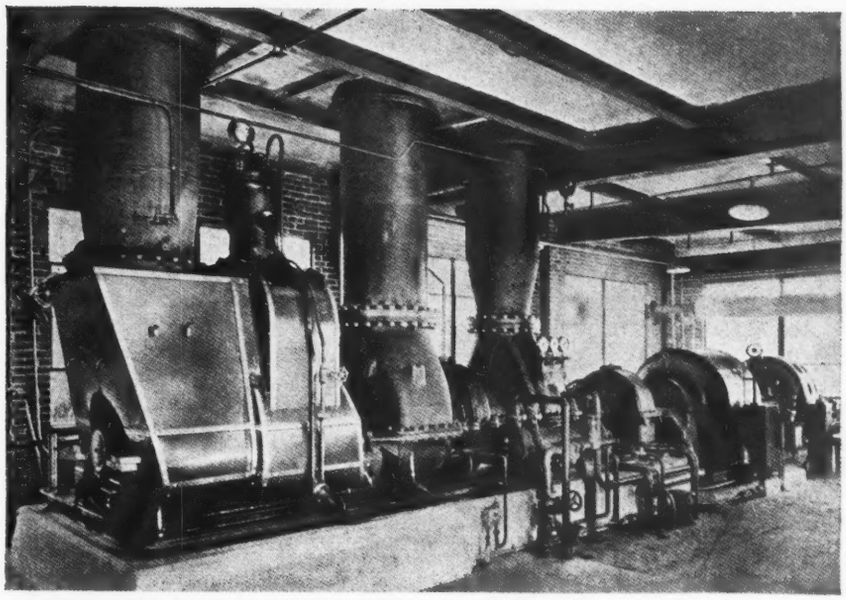


Fig. 3—Gas-turbine supercharging plant at Marcus Hook, Pa., has served the Sun Oil Co Houdry oil-refining process since December, 1936

Work on the gas-turbine axial-compressor unit as an auxiliary to the Velox boiler produced axial-compressor blading of high efficiency by taking into account latest research in aerodynamics. It is this auxiliary unit which has been developed to a high degree of refinement and applied to the Houdry process of oil refining to supply large quantities of compressed air. Power to drive the compressor is generated in the gas turbine by the waste products of the process. Since power produced by the gas turbine is in excess of that required by the compressor, a relatively small amount of byproduct electric power is made.

This unit is shown in Fig. 3 as installed. Waste gas at 950 F enters the gas turbine at the left and exhauts downward to a flue. Air enters the axial compressor at the center, is raised to 45-lb pressure and is then heated in a separately-fired combustion chamber before being delivered to the process. The generator is geared, 5200 to 1800 rpm, and a separate starting motor is provided as shown at the extreme right of the photo.

Pressure drop in the cracking process reduces the amount of byproduct power available below what could be made if the unit were operated for power production only. The gas turbine output is 5300 kw; the compressor requires 4400 kw, leaving 900 kw for electric generation. A separate Velox boiler also supplies steam to the process.

This gas unit has been in practically continuous operation since December, 1936, at the Marcus Hook refinery of the Sun Oil Co near Philadelphia. Altogether, 13 gas turbines are

* *Director, Brown Boveri Co, Baden, Switzerland.*

on order or in operation, see Table I.

Of this list, only the unit for Neuchatel, Switzerland, is primarily designed for power production, the others all serving Houdry process. Not included are gas-turbine-driven blower sets for supercharging diesel engines, of which there are many in Europe and some in this country. In addition, there are a number of Velox boilers in operation served by gas turbines.

Fig. 2 shows diagrammatic hookups for diesel superchargers, Velox boilers, Houdry process and power production. These illustrate that the gas turbine should not be thought of simply as a power producing unit. Practically all applications to date have been made to take advantage of some special feature of the gas cycle, either waste-gas power, compressed air, or, as at Neuchatel, absence of need for cooling-water, cost, and space requirements.

As applied to diesel supercharging, the purpose is to increase power output for a given cylinder size. In the Velox boiler, the gas-turbine and compressor permit high rates of combustion in small space and high heat transfer to evaporating surfaces by stepping up gas velocities. In the Houdry process, the object is to increase the activity of chemical catalysts. For direct power production, advantages are found in elimination of steam-generating equipment and cooling-water requirements. Essentially the same gas turbine suits all these applications. Except for supercharging, which employs a centrifugal blower, axial compressors are of similar design. Thus the same general type of equipment is already serving a variety of special purposes.

How Does It Work?

Operation of a gas-turbine unit is easily understood when compared with a diesel, because essentially the same cycle applies to both. In the engine, air is compressed on the upstroke by absorbing energy from the flywheel. Then oil is forced into the cylinder and burned. On the downstroke, the hot gas expands and delivers more work to the flywheel than was absorbed in compressing the charge. Work required for compression stroke is a large fraction of the work of the power stroke. These similarities extend directly to the gas-turbine set except that the pressure ratio of compression is held down to a range from 2 to 4, instead of perhaps 30 for diesel practice, and the oil is burned under constant-pressure conditions.

Again as in the diesel, excess air is introduced at the burner to keep temperature down to predetermined limits, at present about 1000 F for the gas turbine.

The gas turbine as a power producer has the advantage over a diesel that lowest grades of fuel oil can be fired, and waste gas of any quality or heating value is suitable. Difference in fuel price in many cases makes up for the inherently lower efficiency of the gas turbine in comparison with the diesel.

A gas turbine unit for 2000-kw net output weighs about 40 tons without generator and cost compares favorably with a diesel. Since no cooling water or other auxiliary apparatus is required for the turbine, comparison of investment on a complete-plant basis is considerably in favor of the turbine.

At 1000-F gas temperature, a cycle efficiency of 15-18% can be realized at the generator coupling. Increasing to 1200 F makes possible 18-23%.

Another means of increasing efficiency is adding an exchanger to preheat the air after compression from the gas-turbine exhaust. A surface of 2½ sq ft per kw of net output increases efficiency about 2½ points. These efficiencies are all given as at the generator coupling, and further allowance should be made for generator losses.

Better efficiency at partial loads can be secured by a 2-shaft arrangement, one gas turbine driving the compressor at best compressor speed and another running at constant speed driving the generator. One compressor and combustion chamber supplies both turbines. The effect of this arrangement combined with air preheat is shown in Fig. 4. Thermal efficiency at partial loads is improved as indicated in Fig. 5.

Bomb-Proof Standby Plant

An interesting application of the gas turbine, and the only one to date designed primarily for power production, is the bomb-proof emergency station for the City of Neuchatel, Fig. 6. The illustration indicates the simplicity and small space requirements for a self-contained 4000-kw plant where efficiency is not of prime importance. A small diesel supplies power for starting.

The Allis Chalmers Mfg Co is now engaged in the design and construction of continuous-combustion gas turbines under license from Brown Boveri Co. As indicated by the table, five units are now in process of construction,

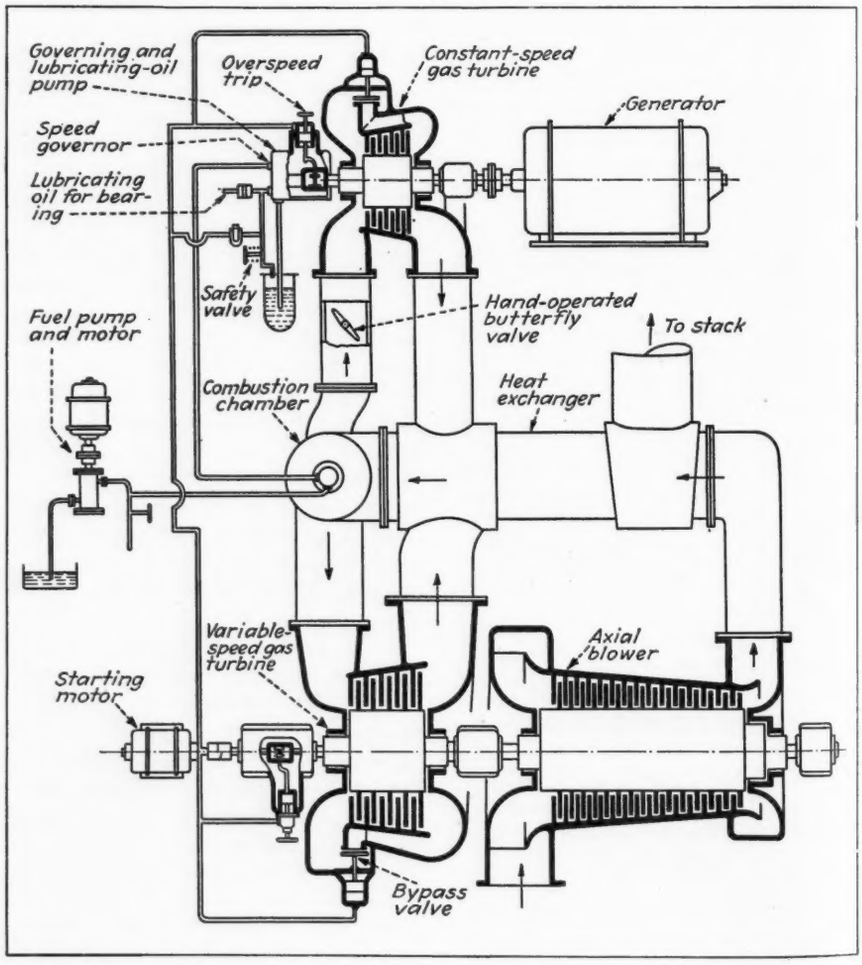


Fig. 4—Two-shaft arrangement for better efficiency at partial loads. One gas turbine drives the compressor, the other a generator. Air is preheated by exhaust gas

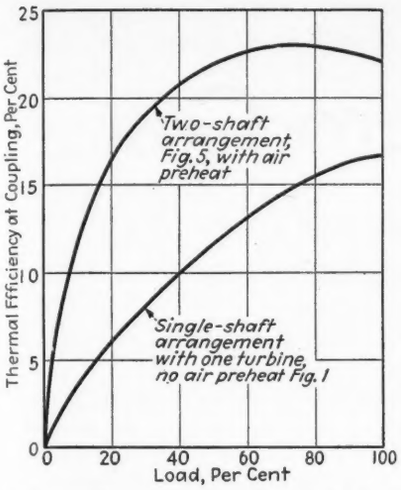


Fig. 5—Thermal efficiency of 2-shaft arrangement with preheat compared to Fig. 1

three of which have completed tests in the builders plant and are being erected.

Concerning the future of the continuous-combustion gas-turbine unit, it is well to ask why no practical application has been found even though engineers have known of the cycle's possibilities for over 100 years. First, the cycle offers no practical net output unless the turbine operates at high temperature. Development of materials and construction for 1000-F steam turbines has brought the commercial gas turbine into being. Another recent development is the Brown-Boveri contribution of the highly-efficient axial-flow blower. Without the latter, the cycle would be unable to show a practical commercial return.

Power generation by the gas turbine is limited at present to liquid or gaseous fuels, as it is too early to predict the outcome of experiments with pulverized coal. Lowest grades of Bunker C oil can be used, however, costing only about half as much as fuel oil suitable for diesels.

Application of the gas turbine to high-speed locomotives is being studied. Freedom from feedwater problems and the elimination of heavy reciprocating forces are inherent in the gas-turbine driving unit. There is a promising outlook in the driving of high-speed ships, particularly destroyers. A substantial weight reduction can be effected.

Other possibilities are found in steel plants or chemical plants where large quantities of combustible gas are available as byproducts. The same situation exists in many oil fields where an excess of natural gas has, in some cases, retarded oil production.

Development in these fields should lead to new applications of gas-turbine equipment. The 1000-F limit should not be taken as the ultimate for operation of the turbine parts. There is a reasonable expectation of increasing this temperature limit, which, when it materializes, will open up still broader fields of application.

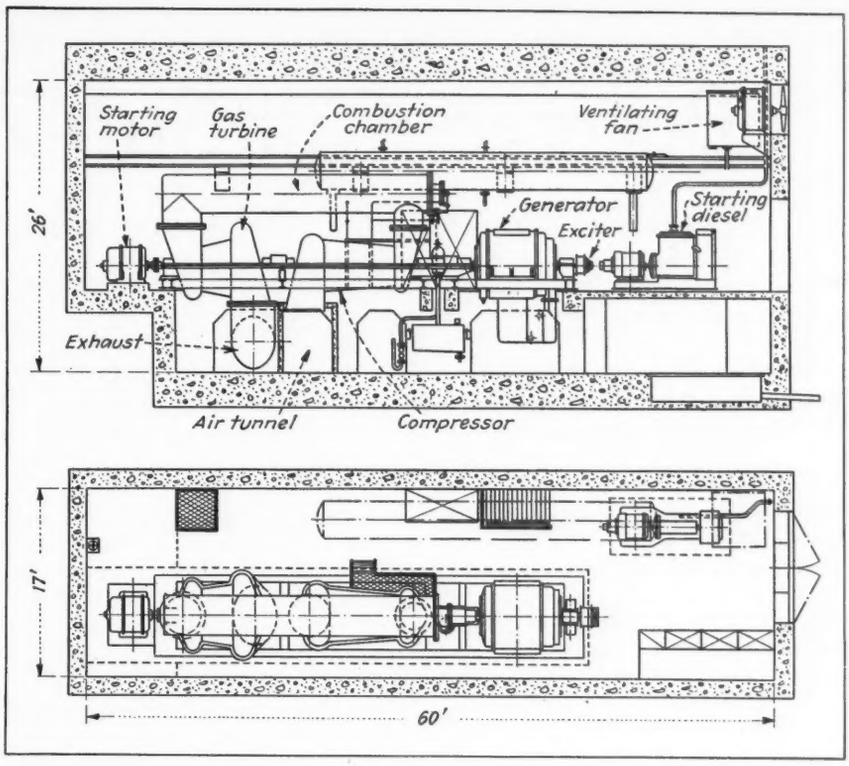


Fig. 6—Bomb-proof 4000-kw standby power plant for the City of Neuchatel, Switzerland, requires no cooling water and no auxiliaries except a small diesel for starting

GAS-TURBINE INSTALLATIONS

Location	*Turbine Output Kw*	*Surplus Power Kw*	*Manufacturer*	*Present Status*
Sun Oil Co, Marcus Hook, Pa	5300	1200	B–B	In operation since Dec 1936 Spare turbine also furnished
Socony-Vacuum Oil Co, Naples, Italy	1380	180	B–B	In operation since June 1937
Magnolia Petroleum Co, Beaumont, Tex	2715	515	B–B	In operation since Nov 1938 Spare turbine also furnished
Sun Oil Co, Marcus Hook, Pa	5300	1200	B–B	In course of erection Spare turbine also furnished
Socony-Vacuum Oil Co, Brooklyn, N.Y	2715	515	A–C	In course of erection
Socony-Vacuum Oil Co, Detroit, Mich	2715	515	A–C	On test floor
Sun Oil Co, Toledo, Ohio	5300	1200	A–C	On test floor
City of Neuchatel, Switzerland	15000	4000	B–B	On test floor
Socony-Vacuum Oil Co, Buffalo, N.Y	2715	515	B–B	In course of erection
Socony-Vacuum Oil Co, Augusta, Kansas	2715	515	A–C	In course of erection
Socony-Vacuum Oil Co, Paulsboro, N.J	2715	515	B–B	On test floor
Socony-Vacuum Oil Co, East St Louis, Ill	2715	515	B–B	In course of erection
Magnolia Petroleum Co, Beaumont, Texas	5300	1200	A–C	In course of erection

B–B — Brown Boveri; A–C — Allis-Chalmers

[*Editor's Note: Another article dealing more intimately with the theory and application of the gas-turbine cycle, authored by an Allis-Chalmers engineer, will appear in a future issue of* POWER.]

Boosters Cut Sub-Zero Cost

Power consumption in single-compression refrigeration plants working at low temperatures drops when easily installed booster compressors are added to handle large-volume, low-pressure work

By C T BAKER
Consulting Engineer, Atlanta, Ga.

LOW-TEMPERATURE refrigeration plays an ever increasing part in modern industrial processes and all indications point to continuation of this trend. Outstanding, of course, is the frozen-foods industry, but low temperatures do their bit in the ice-cream and dairy field, in oil refineries, and in the new but rapidly growing locker-storage industry. 2-stage or booster compression meets many of the operating needs of low-temperature work and in most cases produces substantial power savings over single-stage compression. The simple principles behind its operation, as described here, can be applied to practically any low-temperature refrigeration problem.

Years ago, the ammonia absorption plant was usually considered best for producing low temperatures and certain industries, particularly the oil-refining industry, employed the absorption plant almost exclusively for this class of work. In modern practice, preference goes to compression machines, but early attempts to use these units in low-temperature work were disappointing, particularly because of the high power consumption per ton of refrigeration produced.

Recent development of the booster compressor, used in connection with a standard compressor, enables low temperatures to be produced at real savings over single-stage compression. Early attempts to produce these low temperatures resulted in considerable operating trouble due to the entrance of air around the compressor stuffing box and the tendency for oil to carbonize and gum-up the discharge valves of the machine. This latter trouble came from the abnormally high discharge temperature resulting from the high compression ratio of a single-stage compressor operating with evaporating pressures and temperatures well below zero and discharging against condensing pressure anywhere from 185 to 200 lb.

The modern booster compressor has either a gas- or oil-seal stuffing box, so air is not drawn into the machine even though crankcase pressure is well below atmospheric. Low compression ratio of the booster machine prevents abnormal superheating of the discharge gas, eliminating sticky compressor valves caused by lubricating-oil deposits.

In a large dairy organization handling ice cream and other products, efforts were made to maintain hardening-room temperatures anywhere from 15 to 20 F below zero, by means of single-stage compression. In practically all their plants, high power bills were making inroads on earnings. Installing a booster compressor in one of the largest plants gave a chance to see what such an arrangement could do.

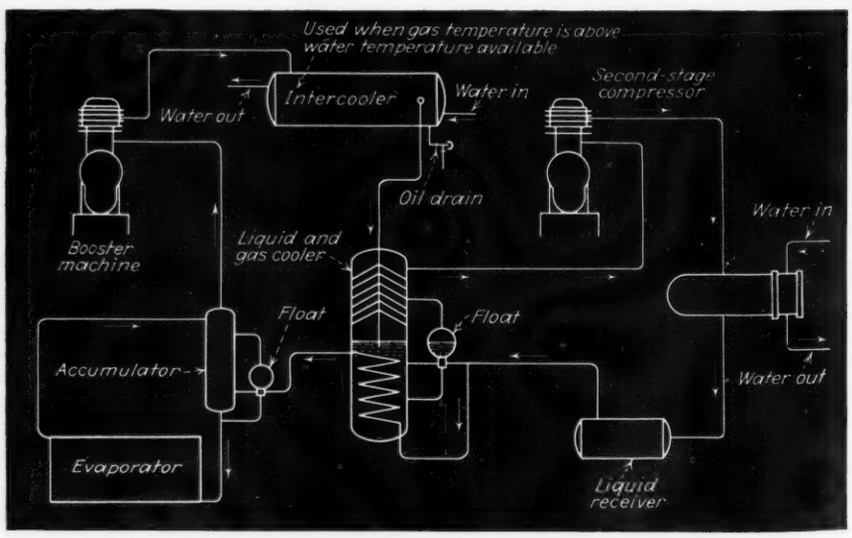
To make this installation it was only necessary to connect the booster machine to the main suction from the hardening-room coils and to connect discharge from the new unit to the main suction of the old compressors, through a gas and liquid cooler.

Gratifying results followed this trial installation; power savings were large, and lower and more uniform hardening-room temperatures were maintained. Since this original step, this company has added booster compressors to other plants with the same satisfactory results.

The diagram shows a typical booster-compressor layout commonly used in low-temperature refrigeration work. Discharge gas from the booster unit goes to an intercooler, entering at the top and leaving at the opposite end to flow to the combined liquid-and-gas cooler. Cooling water for the intercooler flows as shown.

After remaining superheat has been removed in the liquid-and-gas cooler, gas enters the suction of the standard or second-stage compressor. The refrigerant then passes through the usual cycle, receiving further compression in the standard compressor and turning back to liquid form in the condenser. Liquid refrigerant flows from condenser to receiver and then back to the combined liquid-and-gas cooler, as shown.

Operation of the liquid and gas cooler is as follows: gas entering from intercooler is lower in pressure than liquid coming from receiver. Part of liquid enters cooler directly, under control of a float valve, while the bulk flows through the internal cooling coil. Some



Typical hookup for booster compressor

of liquid in cooler constantly evaporates or flashes into vapor, and in so doing takes heat from the remaining liquid and from the gas. Thus superheat is removed from gas, and liquid flowing to evaporator, through coils, is subcooled.

Use of an accumulator with float control valve keeps evaporator flooded. Gas passes off at the top and enters the upper section of the accumulator, and thence out to the booster compressor as indicated. By this arrangement, any liquid carried over with the suction gas from the evaporator is deposited in the accumulator and returned to the evaporator, while the suction gas leaving the top is always free of liquid.

Possible saving in power by direct application of booster compressors to low-temperature work is usually high, often as much as 15 to 20 per cent. The lower the temperature needed and the higher the temperature of the condensing water, the greater will be the saving. In operations requiring production of temperatures ranging from —30 to —40 F, savings in bhp will often exceed 30 per cent. Part of savings, however, are due to subcooling of liquid before delivery to the evaporator.

As an example of the possible savings in power, in an ice-cream plant requiring say, 40 tons of refrigeration to be produced at 0 lb suction pressure and 185 lb condensing pressure, the power requirements will be, by simple or straight compression, approximately 106 bhp. Under the same pressure conditions, the same tonnage can be produced with compound compression with slightly over 90 bhp, or at a saving of about 15 per cent.

One of the principal advantages of the booster compressor lies in the fact that a unit, with necessary auxiliaries, can be easily installed in almost any existing plant producing low temperatures with standard or single-stage compression. Often the saving in power cost will pay for the equipment in a few years; in some cases these savings have completely returned the investment in three years time.

✦ ✦ ✦

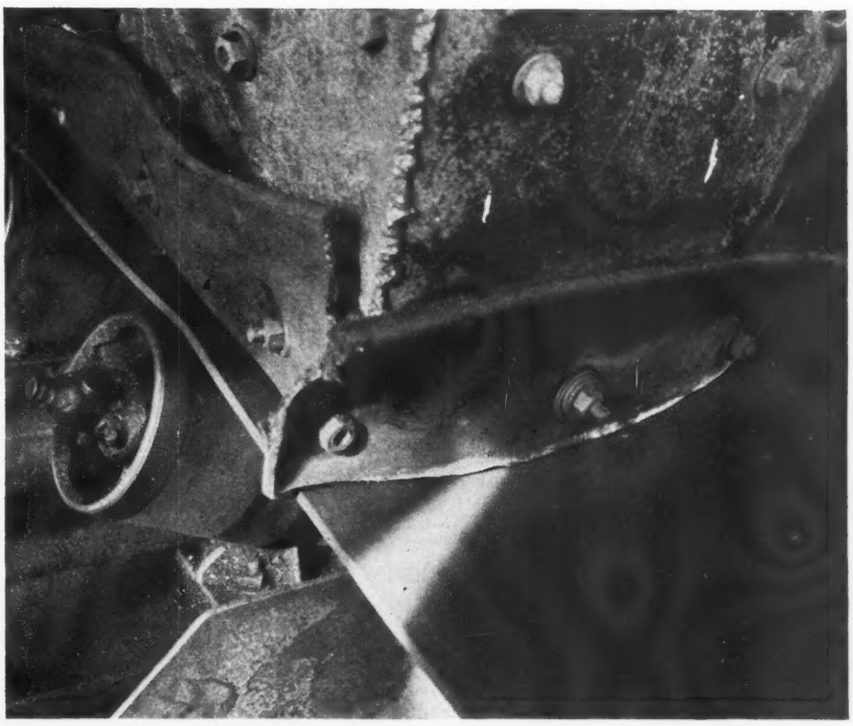
Conveying Oil-Treated Coal

By ALLEN F CLARK
Rubber Chemical Division
E I duPont de Nemours & Co, Inc
Wilmington, Del.

ALTHOUGH treating coal with oil is comparatively new, its advantages have led to quite widespread use in power plants. Oil treatment of coal aids dust elimination, and reduces probability of spontaneous combustion in the coal pile by decreasing the oxidation rate. Spraying coal with oil is also reported to improve coal ignition quality.

A problem created by this new development was effect of oil on rubber belting. Coal not oil treated was handled efficiently by rubber-covered conveyor belts which gave trouble-free service for years. But when, for example, the Stamford Gas & Electric Co, Stamford, Conn., started using oil-treated coal, the rubber-covered conveyor belt softened so that it wouldn't track.

The belt slipped and stretched, changing the tension so that it had to be tightened at regular intervals, and the oil-softened cover was easily abraded by the coal. Finally, after five months, the belt cover swelled to such an extent that the belt humped up and dumped the coal off the sides. All of these difficulties were caused by the oil in the coal. Only seven quarts were sprayed on each long ton, yet the conveyor-belt cover absorbed so much of this oil that after five months, oil could be squeezed out of the rubber.



Neoprene-covered belt handling oil-treated coal, passes under the loading hopper

To eliminate these difficulties, the company replaced the old conveyor belt with one covered with Neoprene to see just what service it would give. A basic characteristic of Neoprene (chloroprene rubber) is its ability to maintain its original properties even after long exposure to oil. This belt has now been in service for over a year and is still in good condition.

Coal is weighed automatically for delivery to the boilers. In the weighing system, coal is delivered from a hopper to one end of a 7-ft Neoprene-covered conveyor belt, which carries it to an automatic scale that stops the delivery each time 300 lb are delivered. Here the belt has been in service for over two years and is still in good condition although subjected to very severe abrasion. Coal under pressure of the load in the delivery hopper drags on the belt at every rotation. Coal also gets between the pulleys and the belt.

What Does Power Cost?

POWER'S editors consider this article the best general survey yet presented of cost comparison between diesel and steam plants up to 10,000 kw. Charts and tables give a quick index to investment charges and operating expense for today's equipment and construction

By H L SOLBERG
Professor of Mechanical Engineering, Purdue University

A SURVEY of modern power-generating plants of 10,000 kw and smaller shows that there is an inherent relationship between size and total cost per net kwhr. To give an idea how the several factors affect total cost of power, and to permit comparison between oil-engine and condensing steam plants, tables and curves have been prepared to show average operating cost in relation to plant size and approximate installation costs on the same basis.

Cost of operation has been obtained from reported figures of typical existing modern installations as a check on estimates. Investment varies between such wide limits that it has seemed preferable to estimate cost of complete plant erected on a consistent basis for all sizes for comparison.

The results must of necessity be accepted as generalizations subject to many variations introduced by price and quality of fuel and labor, adequacy of cooling water, degree of reliability required and the opinions and background of the designer. They will be found to apply to municipal and industrial power plants and smaller central stations.

Harry Solberg, with Purdue University since 1921, has collaborated in much of the high-pressure, high-temperature research on the once-through series boiler. For this article, he has assumed plant locations in the Middle West; the conclusions expressed require modification when applied to varied geographical, fuel or labor-cost conditions.

Because many of the recent installations below 10,000 kw have been extensions of existing facilities rather than new plant designs, and have been influenced by possibility of remodeling or otherwise utilizing existing features of the old plant, few are typical of modern small-plant design that makes full use of developments adapted from the large central-station field. For this reason, estimates and comparisons have been made on the basis of isolated plants without interconnections and not restricted by limitations due to older equipment. Each plant has been designed for a peak load of 65% of installed capacity with three prime movers of equal size. Load factor has been taken to vary directly with installed

TABLE I — PRODUCTION COST OF OIL-ENGINE POWER PLANTS
Based on the Report on Oil-Engine Costs for 1937, ASME

No. of plants	Size range installed, bhp	Computed kw (1) installed	Plant years	Average annual net output, kwhr	Load factor %	Running-plant cap. factor, %	Fuel cost c/gal.	Unit Production Cost, Mills per Net Kwhr: Fuel	Lube	Attd and supt	Repairs, supplies, misc	Total	Computed (2) economy in net kwhr/gal. of fuel	Computed net heat rate based on 142,000 Btu/gal. of fuel oil
1	15,290	10,240	9	29,000,000	49.0	73.1	3.82	3.48	0.45	0.73	1.35	6.24	10.99	12,930
3	11,600–5000	7780–3350	25	9,050,000	37.7	69.7	3.81	3.47	0.35	2.39	1.67	7.88	10.99	12,930
9	5000–3000	3350–2010	56	6,200,000	38.2	65.8	4.31	4.30	0.396	1.81	1.58	8.15	10.01	14,170
20	3000–2000	2010–1340	117	2,658,000	29.8	72.3	4.42	4.46	0.545	3.77	2.96	11.73	9.90	14,350
18	2000–1500	1340–1005	99	1,740,000	26.9	59.6	4.55	4.77	0.528	4.05	2.65	12.00	9.55	14,860
25	1500–1000	1005–670	111	1,705,000	32.4	59.7	4.79	4.89	0.595	3.07	1.96	10.52	9.79	14,500
19	1000–750	670–503	99	794,000	21.6	66.0	4.51	5.02	0.85	6.58	4.20	16.65	9.00	15,770
26	750–500	503–335	125	605,000	24.2	57.9	4.82	5.66	0.831	10.45	4.36	21.30	8.50	16,700
20	500–300	335–201	96	372,000	30.2	45.2	4.84	6.50	1.31	8.65	3.79	20.25	7.34	19,350
14	300–120	201–81	58	179,000	23.6	39.7	5.04	9.01	2.03	6.19	9.37	36.60	5.59	25,400

(1) Installed kw = Installed bhp × 0.746 × 0.90. *(2) Computed from fuel cost in cents per gal. and fuel cost in mills per net kwhr.*

TABLE II — TOTAL PRODUCTION COST OF STEAM POWER PLANTS

Plant No.	Installed kw	Annual net output, kwhr	30-min. peak load	% load factor	Steam press.	Steam temp	Cost of coal $/ton	Heating val of coal Btu/lb	Plant heat rate Btu/net kwhr	Production Cost, Mills per Net Kwhr: Fuel	Attd and supt	Water, lube, etc	Maint	Total
1	3175	5,817,257	1800	37.0	150	366*	4.23	.....	.....	6.20	2.04	0.09	0.90	9.23
2	2240	3,230,940	1050	35.1	175	525	5.60	12,000	36,100	8.41	3.60	0.69	0.58	13.28
3	3500	5,890,711	1600	42.0	175	377*	4.30	.....	.....	6.36	1.58	0.55	0.93	9.42
4	3300	4,048,633	925	49.9	175	520	4.34	14,500	29,600	4.41	3.18	0.71	0.48	8.78
5	2700	6,535,909	1420	52.5	225	550	4.75	.....	.....	4.59	3.06	0.12	0.37	8.14
6	10,000	13,176,501	4300	34.9	...	...	4.77	.....	.....	4.92	1.38	0.43	0.76	7.49
7	3000	6,204,270	2200	32.2	400	700	2.75	9350	27,100	3.94	2.40	0.52	0.58	7.44
8	30,000	41,214,000	10,000	47.0	400	700	2.90	11,379	20,000	2.55	1.10	0.12	0.59	4.36
9	5000**	.....	6200	76.1	450	825	3.53	13,700	16,550	2.14	0.69	0.12	0.06	3.01

** Saturated steam.* *** Data for September, 1938, only.*

capacity from 30% for a 600-kw plant to 45% for 4000-kw and larger. Fixed charges have been computed at 12%.

Diesel Plants

Comprehensive and reliable data on production cost for oil-engine plants is available from annual ASME reports on "Oil Engine Power Costs." Data on 155 plants from the 1937 report has been summarized in Table I, averaging the data for each size range. It will be noted that production cost increases rapidly with decrease in size in the smaller range. Table I forms the basis of the production cost curve in Fig. 2.

A spread of 100% in investment cost is not unusual for oil-engine plants of the same size. Costs are greatly influenced by type of engine, local labor, building and real estate costs, and requirements of the cooling system. Estimated investment in plants having three engines of equal size have been prepared from data obtained from several representative manufacturers; results are shown in Fig. 1.

Heavy-duty and medium-speed engines have been selected in keeping with the assumed isolated nature of the plant to provide the continuous, reliable service expected of a well-managed municipal or industrial plant. High-speed engines could be installed at less cost. The curves, therefore, should not be applied to a specific installation because of the influence of many local factors that can not be considered in this general discussion.

Fig. 2 combines fixed charges computed at 12% of investment with production cost from Table I, making a 5% allowance for auxiliary use. Actually, a shift from medium-speed to heavy-duty engines would affect the production cost somewhat, in a manner not considered in the data of Table I.

The curves indicate a rapid increase in power cost as the size becomes less than 1,000 kw, and would indicate that these small diesel plants are difficult to justify where purchased power rates are reasonably favorable.

Because process-steam requirements vary widely in industrial plants, most of the information of Table II was secured from middle-west municipal plants. For the average of the 9 plants, fuel cost is 62% of production cost while combined fuel and labor accounts for 88%. Excluding one plant too recently placed in service to be typical, average cost of maintenance, lubricants, water and miscellaneous is about 12% of production expense.

Steam Plants

In estimating performance of new steam plants, all have been assumed to have three equal prime movers and sufficient boiler capacity to carry peak load (65% of installed capacity) with one complete unit out of service. For comparison, all plants are based on using 13,500-Btu coal at $4.50 a ton. Turbines from 500 to 5000 kw operate at 385 lb, 700 F.

Turbine-generators rated from 3000 to 5000 kw exhaust at 1½ in. abs. and have three extraction points for feedwater heating, one of which supplies a deaerating heater. One set of heaters serves all three turbines. Three steam-generating units are installed, fired by pulverized fuel and provided with air heaters.

For smaller plants, with turbines rated from 1500 to 2500 kw, vacuum is 1¾-in. abs. and only two extraction heaters are provided. Three stoker-fired boilers are assumed.

For units from 500 to 1250 kw., exhaust pressure is 2 in., one closed heater is used and a deaerating heater is supplied by auxiliary exhaust. Three stoker-fired boilers supply steam.

Prime movers smaller than 500 kw have been considered to be unaflow engines operating at 175 lb, 550 F, with only a single surface condenser for

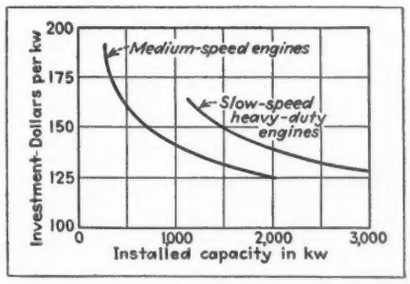


Fig. 1—Estimated investment in oil-engine plants having three equal units

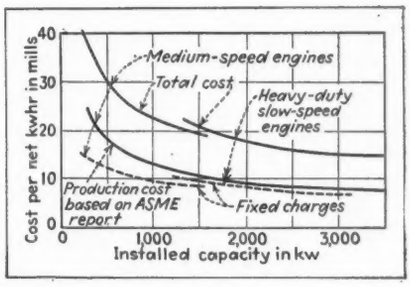


Fig. 2—Total cost per kwhr for oil-engine plants based on estimated installation cost and reported operating charges from 155 existing cases

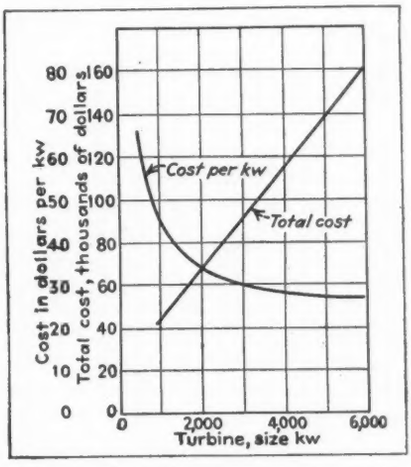


Fig. 3—Approximate cost of turbine-generator sets with exciter, condenser, and auxiliaries, delivered and erected for 450 lb, 750 F or less

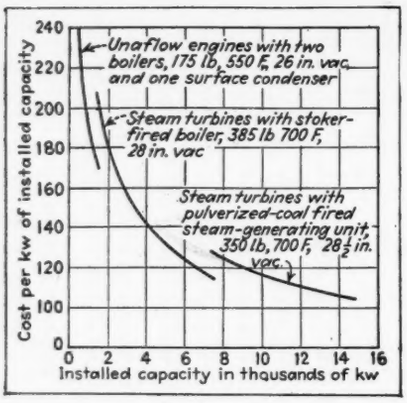

Unaflow engines with two boilers, 175 lb, 550 F, 26 in. vac. and one surface condenser
Steam turbines with stoker-fired boiler, 385 lb 700 F, 28 in. vac
Steam turbines with pulverized-coal fired steam-generating unit, 350 lb, 700 F, 28½ in. vac.
Cost per kw of installed capacity
Installed capacity in thousands of kw

Fig. 4—Estimated investment per kw in steam plants having three prime movers of equal capacity

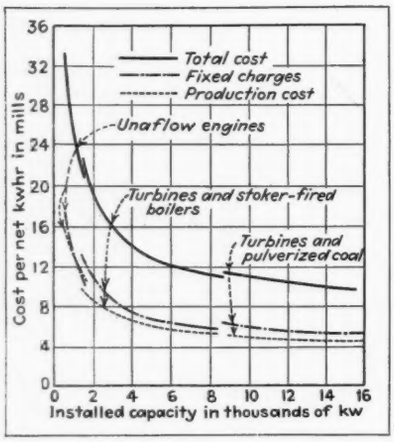


Fig. 5—Total cost per kwhr for steam plants based on data from Table 3

three engines. There are only two boilers, each of which can carry peak load when the engines are operating condensing.

On the basis of these assumptions, approximate plant investment per kw of rated capacity is indicated in Fig. 4. An allowance of 15% has been made for real estate, engineering fees, interest during construction and contingencies. Attention is called to the high unit cost for prime movers of less than 1500 kw.

Expected thermal performance appears in Table III computed on the basis of 76% efficiency for stoker-fired units, 84% for pulverized-fuel boilers, 4–7% of the generator output for auxiliaries and lighting (depending on the heat balance) and an operating efficiency ratio of 89%. Labor costs are based on three 8-hour shifts. Fixed charges are taken at 12%. Total production costs are plotted in Fig. 5.

In general, with fuel cost as high as $4.50 per ton and turbine units of 3000 kw or more, many of the practices of the large central station can be adopted economically. Three stages of feedwater heating, pulverized-fuel boilers with air preheaters and 400-lb to 600-lb pressure at 750 F can be justified, depending on load factor and cost of fuel.

For prime movers of 1250 kw or less, the extraction cycle has a rather limited application, air preheaters and economizers are not justified. It is important to build such plants for low investment rather than for high efficiency. Likewise, unaflow-engine plants should be designed for low cost rather than good thermal performance.

Investment can be reduced by cutting down on reserve capacity, particularly in small municipal or industrial plants where peak loads occur at known periods or some measure of control over the load can be had, for example in the pumping of water. Some engineers feel that reserve equipment is not justified in small plants. Obviously, reserve equipment policy has a marked influence on fixed charges.

As in the case of the smaller diesel plants, the cost of generating power in the smaller steam plants is high in comparison with the rates for purchased power in many sections of the country and it is difficult to justify their construction where the sole product is power unless reserve capacity can be reduced or eliminated.

Diesel sets do not decrease in cost per kw in sizes above 1000 kw as rapidly as corresponding turbine costs nor does their thermal economy increase as much.

An examination of the fuel cost of steam plants from Table III and the fuel cost of oil-engine plants from Table I shows that, for the same plant capacity and on the assumption that both plants contain three prime movers of equal size, the turbine plants will have lower fuel cost per net kwhr. Fuel costs for unaflow-engine and diesel plants of equal size are about the same. This comparison holds only for coal at $4.50 a ton and oil at 4½ cents per gal.; variations in cost of either fuel change the conclusions, of course.

All the foregoing has assumed production for power alone. The material can be adapted to apply to industrial plants having heating or process steam loads by assuming that the heat rate of that part of the plant exhausting steam to process is from 4500 to 4800 Btu per kwhr. This is less than half the heat rate of the best condensing stations. Fixed charges for power are then based on the cost of engine-room and its equipment, plus added boiler-room cost due to increased steam pressure and temperature, plus some increase in boiler capacity to account for the energy extracted from the steam in the prime mover. There will be little difference in boiler-plant maintenance or labor. Under heavy process-load conditions, power can usually be generated at a much lower cost than it can be purchased.

Small-Turbine Characteristics

The foregoing discussion has been influenced to a large extent by the characteristics of equipment now available from the manufacturers. Small steam turbine-generator sets have been fairly well standardized in sizes of 500, 625, 750, 1000, 1250, 1500, 2000, 2500, 3000, 3500, 4000, 5000, 6000 and 7500 kw. The price of condensing sets is independent of initial steam pressure and temperature up to 450 lb, 750 F. Above this, about 4% is added for 825 F and 8% for 900 F. For 650 lb, 750 F, cost is up 7%, 825 F, 10% and 900 F, 14%. These steps should be considered in selecting operating conditions.

Turbines can be obtained with one or two extraction openings at no extra cost provided the steam flow at each opening is less than 15% of the throttle flow. The maximum pressure at which

TABLE III—ESTIMATED PERFORMANCE OF NEW STEAM POWER PLANTS

Installed capacity	*No. and size of units*	*Unaflow engines or turbines*	*Btu input/ net kwhr*	*No. of bleed points*	*Cost per Net Kwhr in Mills*					
					Fixed charges at 12%	*Fuel at $4.50/ ton*	*Labor and supt*	*Repairs, supplies, misc*	*Total prod. cost*	*Total cost*
15,000	3 – 5000	T	17,100	3	5.30	2.85	0.78	1.0	4.63	9.93
12,000	3 – 4000	T	17,300	3	5.56	2.88	0.94	1.0	4.82	10.38
9000	3 – 3000	T	17,450	3	6.06	2.91	1.21	1.0	5.12	11.18
7500	3 – 2500	T	20,100	2	5.82	3.34	1.23	1.1	5.67	11.49
6000	3 – 2000	T	20,400	2	6.32	3.40	1.40	1.1	5.90	12.22
4500	3 – 1500	T	20,900	2	6.92	3.48	1.68	1.1	6.26	13.18
3750	3 – 1250	T	22,300	1	7.50	3.72	1.70	1.2	6.62	14.12
3000	3 – 1000	T	23,200	1	8.60	3.87	2.12	1.3	7.29	15.89
2250	3 – 750	T	23,800	1	10.30	3.97	2.85	1.3	8.12	18.42
1500	3 – 500	T	24,900	1	12.75	4.15	4.10	1.5	9.75	22.50
1500	3 – 500	E	30,800	..	10.60	5.13	4.10	1.7	10.93	21.53
1200	3 – 400	E	31,100	..	12.10	5.18	5.20	1.8	12.18	24.28
900	3 – 300	E	31,600	..	13.80	5.27	6.20	1.9	13.37	27.17
600	3 – 200	E	32,800	..	16.80	5.46	8.50	2.0	15.96	32.76

TABLE IV — COMPARATIVE PIPING COSTS

Steam pressure, lb	*Steam temp, F*	*Valves and fittings, class*	*Weight of seamless pipe*	*Cost, dollars*
250	600	300-lb (Carbon steel)	Standard (Class A)	$6,702
400	750	400-lb (Carbon steel)	Standard (Class A)	$8,972
450	750	600-lb (Carbon steel)	Extra-heavy (Class A)	$10,437
450	750	400-lb (Carbon-moly)	Extra-heavy (Class A)	$9,246
450	825	600-lb (Carbon-moly)*	Extra-heavy (Carbon-moly)	$13,055

** Good for 600-lb, 900 F*

steam can be bled to a feedwater heater is limited to the pressure in the casing after the first stage. This pressure varies from 30 lb abs for a 500-kw unit to 100 lb for a 2500-kw and 150 lb for a 5000-kw turbine. These values are for full load; at partial loads they will decrease in direct proportion to load. Some variation in extraction pressure can be had in sizes above 1500 kw.

The effect of size on the full-load steam rate of straight-condensing turbine sets is indicated in Fig. 6, which shows lower economy of smaller sizes.

Fig. 7 is a plot of the Willans line (steam flow) for straight condensing machines under the same steam conditions. A load of 400 kw can be carried on a 1500-kw machine with little more steam than would be required by a 500-kw unit. The little difference in steam consumption between a small turbine operated near its rated capacity and a larger machine carrying the same load should not be overlooked in selecting turbine size.

Steam-Generating Units

For relatively high priced coal, pulverized fuel firing should be considered for boilers with a steaming capacity of 30,000 lb or more. Designs are well standardized; in general, a 2-drum boiler is supplied with water-cooled furnace walls and air preheater. These units require only low head room and small space and have an efficiency of about 85%.

The cost of such units installed and complete from coal hopper to breaching, including fans, is about $1.80 to $1.20 per lb of continuous steaming capacity in sizes from 30,000 to 70,000 lb per hr at 425 lb, 720 F.

In this capacity range, the 4-drum boiler fired by a multiple-retort stoker has many advocates and is somewhat less costly.

For capacities less than 30,000 lb per hr, a number of designs are available with efficiency of 76–78%. Some are designed for shipment from the factory completely erected in a steel casing to reduce labor of installation.

Piping

Standard service ratings for valves and fittings are at 750 F and 300, 400, 600, 900 and 1500 lb. At higher or lower temperatures, pressure ratings are adjusted, for example, a 600-lb standard valve can be used for 500 lb, 800 F, or 450 lb, 825 F. Pressure ratings are higher for cast carbon-moly steel valves.

For 750 F and lower, Grade A seamless carbon steel pipe is recommended for all pressure classes. Over 750 F, carbon-moly is recommended.

The author is indebted to the Crane Co for a careful estimate of the cost, erected in place including insulation supports and hangers, of a high-pressure steam piping system connecting three steam-generating units and three turbines to a common steam header for several steam conditions, Table IV.

It will be noted that cast carbon-moly steel valves and fittings makes piping cost for 450-lb, 750 F, only a little more expensive than for 400 lb, 750 F. However, when temperature exceeds 750 F, carbon-moly steel pipe and cast carbon-moly headers instead of welded carbon-steel headers results in a considerable expense. These factors should be considered in selecting steam conditions.

Also, the fact should not be overlooked that pressures over 400 lb require increased attention to feedwater treatment if troubles are to be avoided.

The author wishes to thank the power-plant superintendents and representatives of equipment manufacturers for their cooperation and assistance. He is especially indebted to W H Winslow of Purdue University for his assistance in making many of the detailed computations required in the preparation of this report.

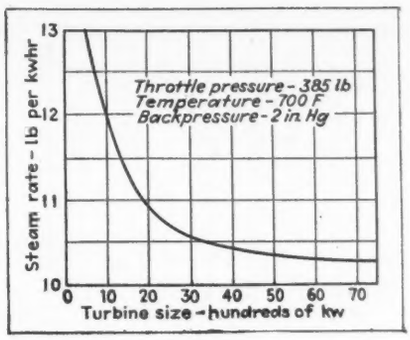


Fig. 6—Full-load steam rate of straight condensing turbine sets

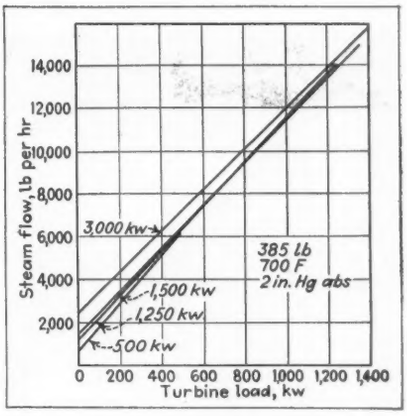


Fig. 7—Willans lines for several sizes of turbines operating straight condensing under the same steam conditions

Welding Tips

USED DENTAL DRILLS AND BURRS which have become too dull for dental work, and which can be obtained from most dentists, are excellent tools for "veeing" small parts for welding, or for finishing small intricate metal parts. Simply fix them in a small portable electric drill by a chuck.

SOFT FLUFFY WOOD ASHES make good insulation to assure slow cooling off of preheated parts.

AFTER CAST IRON HAS BEEN VEED for welding, a good trick is to open up the bottom of the vee with a hack-saw blade so that there is a slight spacing of the edges. By so doing, many small simple cast-iron shapes can be welded with little preheating other than locally applied with a blowpipe flame. Expansion and contraction strains set up by heat of the welding operation are considerably relieved by this spacing.

EXCELLENT GASKET CUTTERS can be made by welding various-sized steel balls on the ends of strong steel shanks about 4 in. long. With the ball end placed on the gasket material over the hole to be fitted, a sharp tap on the end of the shank will cut out a good clean hole. Of course, a ball larger in diameter than the hole is necessary. Old hollow wrist pins ground to a sharp edge at one end also make good gasket-hole cutters.—*Abstracted from* OXY-ACETYLENE TIPS.

Scale Models Aid the Engineer

The same technique used by Tennessee-Valley Authority engineers in design of hydraulic structures can be economically applied to turbine-room, boiler-plant, coal-handling equipment and other steam-plant structures

By H L von HOHENLEITEN, *Formerly Associate Structural Engineer, TVA*

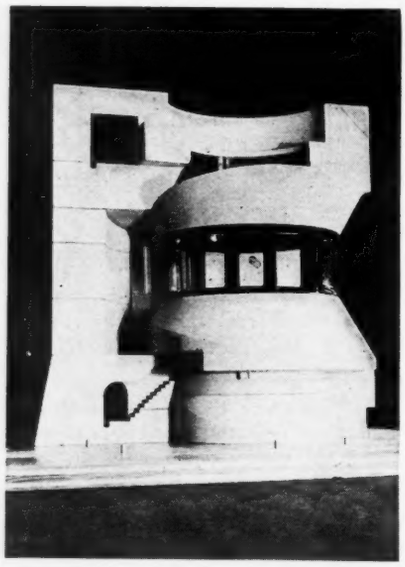


Fig. 1—Model of a scroll case for a hydraulic turbine unit

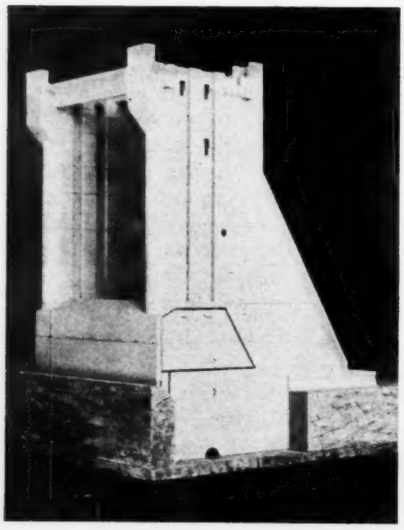


Fig. 2—Model of a spillway-gate piers for a hydroelectric-plant dam

Fig. 3—Topographical model made to the same horizontal and vertical scale

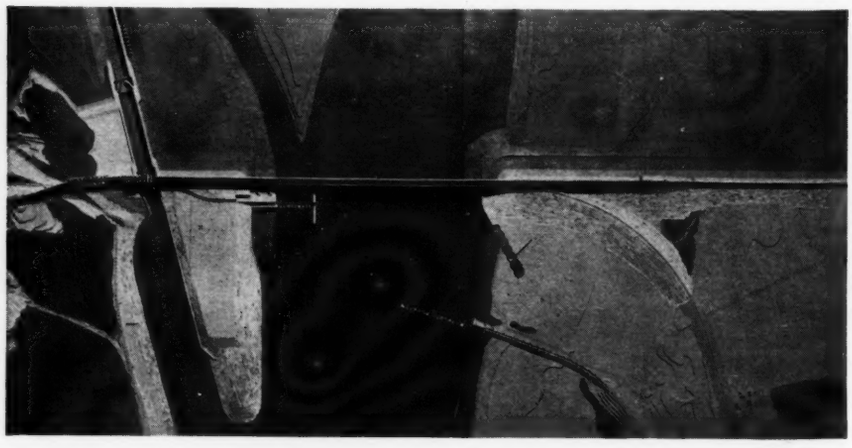
MODELS HAVE PROVEN to be of such value for display that their continually increasing popularity speaks for itself. In the past decade, the engineering profession has begun to adapt this new medium and has found it very satisfactory in studying hydraulic and stress-analysis problems.

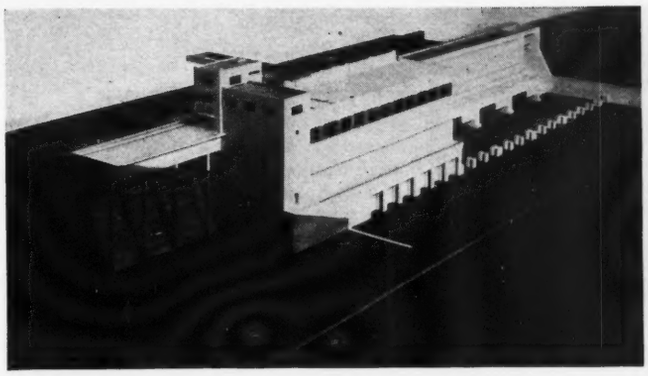
But the model as an aid to the design and field forces represents a comparatively new idea and as such has only been recognized in recent years. The advantages that this new branch of model construction offer lay primarily in its 3-dimensional expression, which not only provide engineers with a clear picture, but also make it possible to bring a story home to the layman where blueprints have failed.

The model fulfills its purpose to the greatest advantage when it is built prior to or concurrently with the design of a structure. A reason why this new medium has not been used to a much greater extent may be that adequate personnel is not readily available and that, heretofore, prices paid to private concerns were out of proportion. The personnel question is a difficult one as the successful model builder must, in my opinion, be an engineer with a sound general knowledge and endowed with the skill of an expert craftsman. Practical applications have shown that a model, which will satisfactorily explain what 10 or 12 detail drawings reveal to the expert after intensive study, can be built for the cost of a few drawings.

In December, 1936, the Tennessee Valley Authority found it advisable to establish a shop at Norris, Tenn., capable of handling a wide variety of model work to fill the needs of all departments. Since its opening, this shop has produced models and experiments at a rate of approximately two per month. These have proven a great help to the design department as well as the field forces of the Authority. Types of models built in this shop may be roughly classified into five groups: construction, architectural, topographic, electrical and special.

Construction models cover primarily structural features and are confined to parts that represent special problems. They are usually made of separate wood blocks the exact size of individual lifts, or concrete pours, and can be assembled or taken apart at any construction joint. They not only enable the designer to get the feel of the job, but point out to him places where he may expect trouble. Such a job may easily be made from preliminary drawings. If the model shows existence of a tendency toward featheredges at joints,





Figs. 4 and 5—How models were used by TVA engineers to judge power-plant architecture

or points to a better proportioning of pours, it is an easy matter to change individual blocks until a satisfactory solution is found.

This type of model will more than pay for itself by the time-saving it makes possible in the detailing of a structure. But it has by no means finished its usefulness, as it can be shipped to the field where the construction engineer assembles it one step ahead of construction. In this way he may solve intricate formwork details immediately confronting him, with his foreman. Fig. 1 shows a model of a scroll case and Fig. 2 a model of a spillway section of a dam. These models have the advantage that they can be taken apart to reproduce 3-dimensional cross-sections that could not be obtained otherwise.

Architectural models are usually executed to a fairly small scale and may range in scope from small architectural details to models of complete structures. They enable the architect to visualize all his problems before design drawings are completed and improve on them before any changes involve large expenses. In many instances, parts of the model may be made removable and such questions, as whether the appearance of a building may be improved by extending a wing or adding a story, may be settled at a glance. An accurate scale model has the further advantage of showing a building exactly as it will appear and eliminating all effects due merely to the skill of the architect in rendering. Examples of this type of work are shown in Figs. 4 and 5.

Topographic and landscape models have been used for so long that they hardly need mention. Engineering groups that are concerned with planning activities have found models extremely useful for layout work as well as for selling their ideas to non-professional groups. Again faithfulness to scale enables the user to do his planning in three dimensions rather than in the 2-dimensional drawing.

Fig. 3 shows a topographic model that was built to the same horizontal and vertical scale for the design department. Such models are especially valuable when made in the early stages of a project. Highway and railroad bridges, construction plants, spillways, and power houses may all be made removable; in this manner, one model may serve to illustrate several schemes. Again, this 3-dimensional picture conveys the idea of the most intricate setup at a glance, where it would be otherwise necessary to make an intensive study of numerous plans, elevations, and sections.

Special cases in the structural as well as in the mechanical field, in which models may be used to advantage, are so numerous that they can not be mentioned in this article. Outstanding examples of this type are a skeleton model of a draft-tube, Fig. 7, and a model of a crusher plant Fig. 6.

A draft-tube with its complex curvatures presents a very difficult problem for solution on a 2-dimensional drawing. In order to overcome these difficulties, a new type of model was developed by the author and subsequently used to check the draft-tubes of two of the Authority's projects.

The model of the crusher plant was built so that all mechanical elements, like screens, chutes, and crushers, could be taken out and shifted around until an economical and mechanically correct layout was found.

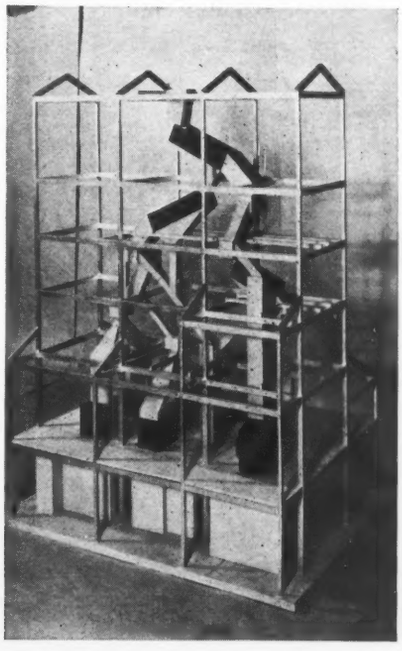


Fig. 6—Model of stone-crusher plant, built so that all mechanical elements can be taken out and shifted to get the most economical arrangement

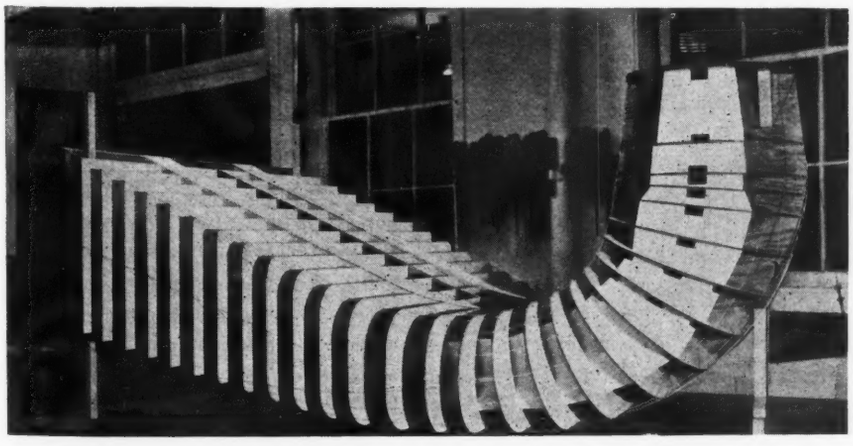
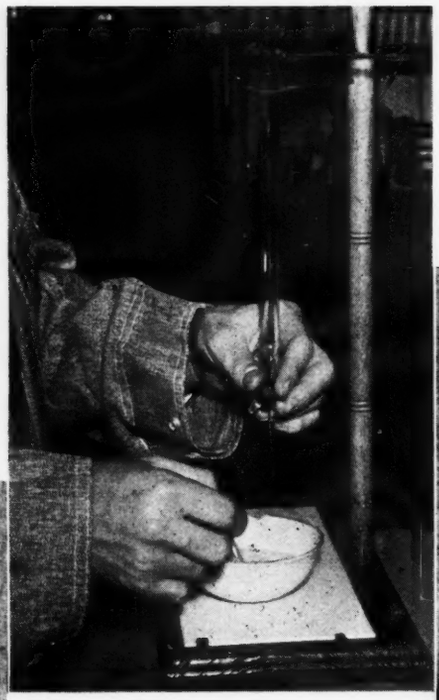
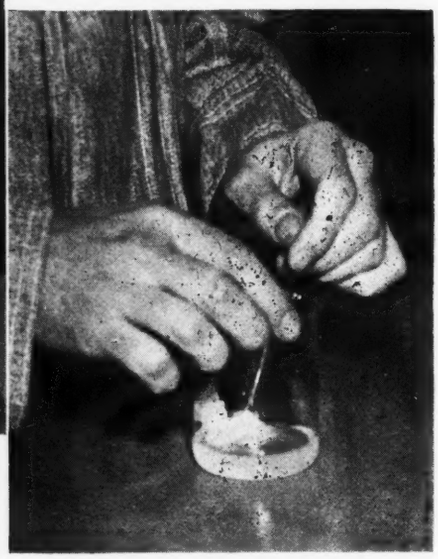


Fig. 7—New type of draft-tube model developed by the author to check draft-tube design

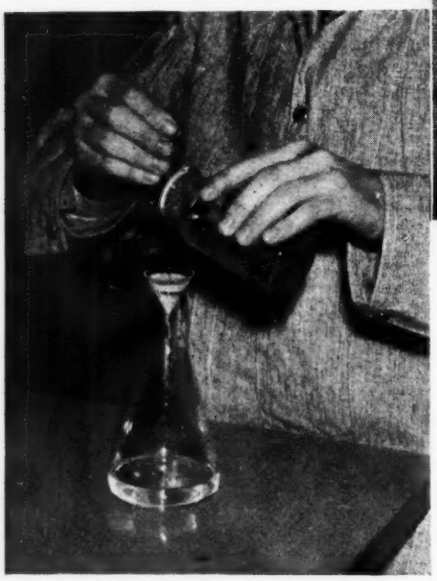
When end of titration approaches, set burette cock to drip slowly (a drop at a time) and stir with free hand



After washing sulphate precipitate from filter paper to beaker with 25 cc of distilled water, mash up filter paper in the solution



Pouring sample down glass stirring rod keeps water from getting between filter paper and funnel



How One Engineer

Whether you are now testing boiler water yourself, or whether you often thought of doing so but were scared away by technical difficulties, you will find useful pointers in this practical presentation of testing "do's and don'ts"

By T D OSWALD

Power Station Superintendent
Newcastle & District Electric Ltg Co, Ltd, England

TEXT BOOKS give the theory and leave out the practice of boiler-water testing, as in the case of many other everyday powerhouse jobs. Thus we are told that to avoid priming, scale, burst tubes, embrittlement, and all the other troubles blamed on bad water, we must condition our boiler water. We are told that the chemicals present must occur in certain quantities or there will be trouble. However, the secret of maintaining correct conditions lies in testing; if reliable test results are available application of the theory lies well within the capacity of a man accustomed to using horse sense.

Our experience shows that consistency of results is vital and that to insure consistent results a routine must be observed. We reduce our routine to four basic tests, each a titration. The text books describe them as follows:

ALKALINITY—Add 2 drops of phenolphthalein indicator to a 70-millilitre sample (in U. S. 58.3 ml) and titrate with deci-normal acid until neutral. Multiply ml of acid used by 5 to get *phenol alkalinity* (P). Add 2 drops of methyl-orange indicator and continue titration until neutral. Total ml used multiplied by 5 gives *total alkalinity* (M). Alkalinities expressed as grains per gal. of calcium carbonate.

HARDNESS—Titrate a 70-ml sample (in U. S. 58.3 ml) with standard soap solution, shaking well. Titration is complete when a lather lasting 5 minutes is obtained. Number of ml of soap solution used minus 0.7 ml gives *hardness* (H) expressed as grains per gal. of calcium carbonate.

CHLORIDE—Add 2 drops of potassium chromate solution to a 70-ml sample (in U. S. 58.3 ml) and titrate with 1/58.5-normal silver nitrate until a permanent pink tinge is obtained. Number of ml used gives directly the *chlorides* present, expressed as grains per gal. of sodium chloride.

SULPHATE—Add 10 ml of benzidine hydrochloride solution to a 70-ml sample (in U. S. 58.3 ml) and filter off the precipitate. Mix the precipitate with 25 ml of distilled water, add 2 drops

Pointers on Standard Solutions

Buy or Make?

In plants where the engineers are required to carry out the tests, best plan is to purchase reagents and indicators ready made to correct strength, from a local chemical supply house. Making up the solutions is a chemist's job. We have tried our hand at making up some of them and couldn't justify the time involved in getting them right. Moreover, they deteriorate in keeping. Soap solution, in particular, is liable to concentrate and low hardness tests should be suspected if solution is a month or so old.

How to Specify:

Based on our experience, the best way to operate is to hold small stocks, one or two litres, replenishing as needed by purchase. We specify the solutions as follows:

ACID—Standard deci-normal acid. Sulphuric or hydrochloric are easiest to obtain. It is immaterial which is used.

SOAP SOLUTION—Wanklyn's standard soap solution is used—Castille soap in alcohol. One ml corresponds to one grain per gal. of calcium carbonate, allowing for a fraction which is required to produce a lather, even with distilled water. In our solution, this fraction is 0.7 ml; it is usually marked on the bottle.

SODIUM HYDROXIDE—Standard one-seventh normal solution.

SILVER NITRATE—Standard 1/58.5 normal solution.

BENZIDINE HYDROCHLORIDE—Made of 20 gm crystalline hydrochloride dissolved in a 10% solution of concentrated hydrochloric acid. Strength of this solution does not need to be exact.

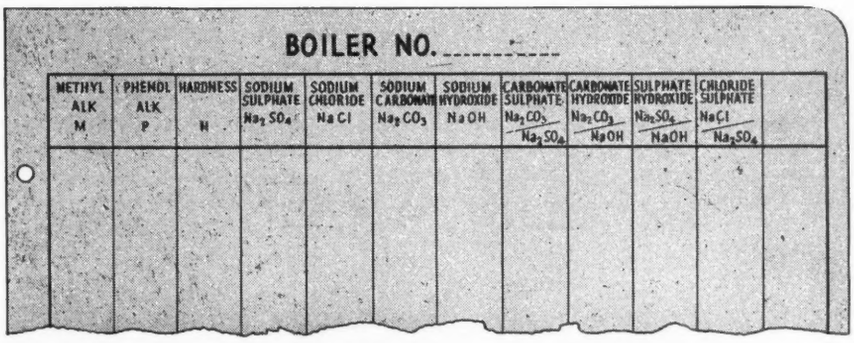
METHYL-ORANGE INDICATOR—Dissolve 0.5 gm of methyl orange in a litre of distilled water.

PHENOLPHTHALEIN INDICATOR—Dissolve 5 gm of phenolphthalein in one litre of 50-50 alcohol and distilled water, and neutralize.

POTASSIUM-CHROMATE INDICATOR—Dissolve 50 gm of chromate in a little distilled water, add silver nitrate until a precipitate just forms, stand over night, filter, and make up filtrate to one litre of distilled water.

Note: Strengths of solutions are standard and are not affected by difference between U S and Imperial gallons. This is compensated for by the size of sample taken. In the U S the sample is 58.3 ml while in the United Kingdom it is 70 ml. Otherwise the tests are identical.

Tests Boiler Water


BOILER NO._____

METHYL ALK M	PHENOL ALK P	HARDNESS H	SODIUM SULPHATE Na_2SO_4	SODIUM CHLORIDE NaCl	SODIUM CARBONATE Na_2CO_3	SODIUM HYDROXIDE NaOH	CARBONATE SULPHATE Na_2CO_3 / Na_2SO_4	CARBONATE HYDROXIDE Na_2CO_3 / NaOH	SULPHATE HYDROXIDE Na_2SO_4 / NaOH	CHLORIDE SULPHATE NaCl / Na_2SO_4	

This is the way the author rules each page of his boiler-water test book

of phenol indicator, and titrate with 1/7 normal sodium hydroxide until a pink color which will last 30 seconds is obtained. Multiply ml used by 10 to get *sulphate* expressed as grains per gal. of sodium sulphate.

So much for the text books. In practice, certain difficulties crop up. In the first place, precautions have to be taken to obtain a consistent sample; any old way won't do. We have extracted samples from four different points of our bent-tube boilers and obtained entirely different test results from each. For another thing, the amount evaporated from a sample blown directly into the sample vessel varies widely, leading to inconsistencies. By trial and error, we developed a sampling method which eliminates most of these difficulties and gives us absolutely consistent samples.

Samples are taken at the blowdown connection on the gage glass, by connecting the inlet pipe of a home-made condenser in place of the usual pipe. The condenser consists of a coil of copper tubing immersed in an old oil drum, 2-gal. size. The inlet end protrudes vertically at the height of the blowdown connection and is fitted with a nipple to suit. Carrying the outlet end up over the side of the drum and turning it down permits discharge into the sample vessel which is an ordinary galvanized jug.

To take the sample, the top cock of the gage glass is shut and the glass first thoroughly blown out, to remove condensed water. About half a gallon is then drawn off into the vessel.

For the tests, the necessary kit is:

4—25-ml burettes on stand
2—250-ml breakers
1—500-ml conical flask
1—200-ml sampling bottle
1—100-ml measuring cylinder
1—25-ml pipette
1—10-ml pipette
1—15-cm funnel
1—5-cm funnel
1—Glass stirring rod

Reagents and indicators (see tabulation)

A word about the kit will be of service. Burettes are most important; they should be graduated to 0.1 ml. On the side opposite the engraving they should be fitted with a white background with a narrow blue line running the length of the burette. When viewed from the front the meniscus of the liquid causes this blue line to distort so that it appears to form two arrow heads pointing unmistakeably to the correct reading. Beakers should be provided with lips for easy pouring. The sampling bottle is for use in the soap test and should have a rubber stopper, not a cork. Using a measuring cylinder will be found superior to a pipette because of ease of cleaning.

Filtering

Samples should always be filtered. It is a good tip to combine the operations of filtering and measuring. Place the large funnel, complete with filter paper, in the measuring cylinder and filter the sample directly into the cylinder. The liquid runs steadily and it is an easy matter to remove the funnel at the exact moment the correct mark is reached.

Now for the testing. In the following description of the routine used, the method of presenting each test from start to finish was abandoned in favor of showing the exact sequence of operations, indicating how the different phases of testing can be combined to save time.

The first sample, which is used for the sulphate test, is poured into a

beaker and the filtering of a second sample begun. Benzidrine hydrochloride is drawn into the small pipette and added to the first sample. While the precipitate of sulphate forms, the second sample is poured into the sampling bottle for use in the hardness test, and filtering of a third sample started.

Precipitation in the first sample should by now be complete. Place the small funnel in the neck of the conical flask and pour a portion of the sulphate sample into the funnel. This filtering job is apt to be somewhat lengthy. We use 4.5 cm filter paper because the smaller the amount of paper present when the final titration is made the more discernable the color change, and hence the more consistent the result. It is for this reason that the sulphate test is started off first. During the remainder of the tests the sulphate filtering funnel must be constantly replenished. In order to avoid risk of getting some of the sample between the filter paper and the glass side of the funnel, the liquid should be poured down the glass rod, right into the middle of the funnel.

The third sample will by now be ready and can be poured into the remaining beaker ready for the alkalinity tests, and a fourth sample can be got under way.

Titration

Now return to the hardness sample and commence titration with soap solution, running in about 0.4 ml at a time, shaking the bottle well between each addition. With a little experience it is possible to tell by the "feel" of the shake when the titration is complete. An experienced hand rarely has to resume titration after waiting to see if the lather will last. Noting height of the lather makes a useful guide; the lather will be stable, in most cases, if it stands ¾-in. above the water in the bottle, standing vertically. To test lather permanency lay the bottle on its side, note the time, and start the next test.

Next comes the alkalinity test; there are no catches in this one. It is a straight titration and the color changes are easily observable. Add acid solution drop by drop from the burette until the pink color from the phenolphthalein just disappears. For methyl-orange or total alkalinity, add acid until orange color just changes to red. At the end of this test refer to the soap bottle and if the lather is still there, take the burette reading; otherwise add more soap and shake.

Now throw out the alkalinity sample, rinse the beaker and pour the fourth sample into it. This is for the chloride test. The difficulty met in this test is to catch the true completion of titration. As addition of silver salt proceeds a cloudy precipitate forms which obscures the appearance of the pink color. We find the best way to run this test is to run in silver nitrate until the end point is approached and then add a drop at a time by setting the burette cock to drip slowly; we also stir well between each drop, using the glass rod. Before the titration is complete, as each drop enters the liquid a red splash appears. When titration *is* complete, no red splash appears. This test is trickiest of the lot and practice is necessary.

Sulphate Test

By this time all the sulphate sample should be filtered and the precipitate of sulphate left on the filter paper. Remove paper and precipitate on it from the funnel and place in the beaker which lately contained the sample. By suitable manipulation with the stirring rod, open the paper so as to expose the precipitate and squirt 25 ml of distilled water from the large pipette. Using the rod, thoroughly mash up the paper and then add 2 drops of phenol indicator. In titrating with alkali, set the cock to drip when completion is approached, as was done in the chloride test, and keep the sample well stirred.

[Ed. Note: In this country at least two other methods of sulphate determination are commonly used: one employs tetrahydroxy quinone as an indicator and is a straight titration, the other employs the turbidimeter.]

Using the Tests

While this article set out to give practical suggestions on running the tests, a few pointers on how we use them may not be out of place. First of all they are entered in a test book, in which each boiler has a page of its own, ruled off into 12 columns. Phenol and methyl alkalinities come first, followed by the hardness, sulphate, and chloride values as found in the tests.

The next two column entries are sodium carbonate (Na_2Co_3) and sodium hydroxide (NaOH) which are calculated from the formulas,

$Na_2CO_3 = 1.06\ [2(M - P) - H]$ (grains per gal.)

$NaOH = 0.8\ (2P - M)$ (grains per gal.)

The next column contains the ratio: sodium carbonate over sodium sulphate. This was originally introduced as a scale prevention index; if it exceeded a certain value, depending on boiler pressure, it was said no scale could be deposited. We found that fact and theory didn't always agree on this point, but still retain the figure in the book, as it forms a useful guide to the constancy of treatment.

Embrittlement Ratios

Ninth and tenth columns contain the embrittlement ratios $Na_2CO_3/NaOH$ and $Na_2SO_4/NaOH$. These we check against the standard embrittlement curves, copies of which are pasted on the cover of the book for ready reference.

Eleventh column shows sodium chloride over sodium sulphate. This ratio is extremely useful. When salt water is used for condensing, changes in the ratio will reveal otherwise undiscovered condenser leakage. When compared with the ratio obtained from similar tests on the feedwater, it is possible to reveal the extent of scale formation in the boiler. The underlying theory states that chloride passes through the boiler unchanged but sulphate will be deposited, in part at any rate, if scale is being deposited. If the chloride over sulphate ratio of the feed is less than that of the water in the boiler, then some sulphate has been deposited in the boiler.

This does not work out quite so simply in practice. We have overcome scale deposition and yet our ratio still increases as the water passes through the boiler. Perhaps our tests are not sufficiently accurate, but we don't worry as long as they are consistent. Consistency in testing is the quality to aim at. That's why we have arrived at what we consider to be the best method and why we stick to it.

The twelfth column in the book is blank. Good engineers always have a little in hand for emergencies.

Pictures taken with cooperation of Water Service Laboratories, Inc., New York, N. Y.

CORRECTION

In the table of equipment published as part of the article, "A Small Plant Saves", May, 1938, POWER, the Keystone Engineering Co, Philadelphia, Pa., should have been given credit for conditioning and moving the steam engines at the White Haven Sanatorium.

NEXT *to knowing when to seize an opportunity, the most important thing in life is to know when to forego an advantage.* —Disraeli

Oil & Gas Power

Information, Please

NO MORE GLAMOUR than a tugboat; all the everyday usefulness of a Stillson wrench—that about sums up the following pages, POWER's 7th Annual Oil and Gas Power Section. This year's includes engineering data on 380 oil-engine and 80 gas-engine installations, totalling more than 220,000 hp; a roundup of rating data for oil and gas engines available in the United States; and a classified directory of manufacturers building accessories and supplies.

Here, gathered into one handy section, are answers to everyday questions: Who's put in big air-injection engines recently? Are engine speeds still going up? What industries find oil or gas engines the answer to their power needs? Who builds the size and type engine I think my plant needs? Are other engineers with similar plants using engines such as I think I want, or am I off on the wrong foot? What companies ought to be invited to bid on that new cooling tower? Is use of sewage-sludge gas growing?

POWER's editors know these are the questions because some like them come to the office every day, by phone and mail, from across the street and from far corners. POWER's editors know the Oil and Gas Power Section answers many of the questions because it's the first place they turn when editorial heads, crammed with odd facts but definitely not infallible, don't yield the answer. And in addition to the answer, the inquiring engineer always gets a copy of the current section, so he'll have the data at hand when another problem comes up.

Here's your copy—put it to work!

Typical Diesel Installations

380 Plants Installed or Under Construction Since April 1, 1938

Owner	Location	Equip. Driven	Engine Builder	No. Units	Hp Each	Rpm	No. Cyl	Cyl Bore	Cyl Stroke	Cycle	Starting Method	Fuel Injection	Fuel, lb per hp hr	Other capacity, hp. in same plant
U. S. Indian Irrig. Serv.	Coolidge, Ariz.	C. S. Gen	Nord	1	2700	225	8	21	29	2	A	A	....	2600-D
Sturgis	Michigan	Mun. Gen.	BuS	1	2675	240	8	20½	27½	2	A	S	0.39	1750-D
Hillsdale	Michigan	Mun. Gen.	Nord	1	2250	225	6	21	29	2	A	A	....	.....
Western Public Service Co.	Chadron, Neb.	C. S. Gen.	Nord	1	2000	257	8	17	25	2	A	A	....	.....
Hutchinson	Minnesota	Mun. Gen.	Nord	1	1500	257	6	17	25	2	A	S	0.36	1920-D
Federated Coop. Power Assn.	Hampton, Iowa	C. S. Gen.	Nord	1	1500	257	6	17	25	2	A	S	....	1750-D
Potash Co. of America	Carlsbad, N. Mex.	Ind. Gen.	Nord	1	1500	257	6	17	25	2	A	A	....	.....
Rensselaer	Indiana	Mun. Gen.	Nord	1	1500	257	6	17	25	2	A	S	....	2850-D
Red Bluff Wtr. Pwr. Cont. Dist.	Pecos, Texas	Standby Alt.	ALC	1	1440	300	8	14	23½	2	A	S	0.40	Hydro
Iowa Public Service Co.	Sioux City, Iowa	C. S. Gen.	FM	1	1400	300	6	16	20	2	A	S	....	.....
F. W. Stock & Sons, Inc.	Hillsdale, Mich.	Ind. Gen.	Nord	1	1250	257	5	17	25	2	A	A	....	.....
Lamar	Missouri	Mun. Gen.	FM	1	1225	300	7	16	20	2	A	S	0.37	1200-D
				1	1050	300	6	16	20	2	A	S	0.37	.....
Goodland	Kansas	Mun. Gen.	FM	1	1225	300	7	16	20	2	A	S	....	.....
La Junta	Colorado	Mun. Gen.	FM	1	1225	300	7	16	20	2	A	S	0.37	.....
				1	1050	300	6	16	20	2	A	S	0.38	.....
				1	700	300	4	16	20	2	A	S	0.37	.....
Farmville	North Carolina	Mun. Gen.	ALC	1	1170	257	8	17½	25	4	A	S	0.39	1200-D
Thibodaux	Louisiana	Mun. Gen.	ALC	1	1170	257	8	17½	25	4	A	S	0.39	D
Maquoketa	Iowa	Mun. Gen.	ALC	1	1145	257	8	17½	25	4	A	S	0.39	D
Marblehead	Massachusetts	Mun. Gen.	ALC	1	1080	277	6	14	23½	2	A	S	0.40	S
Houma	Louisiana	Mun. Gen.	ALC	1	1080	277	6	14	23½	2	A	S	0.40	D
Glencoe	Minnesota	Mun. Gen	FM	1	1050	300	6	16	20	2	A	S	....	.....
Dupont Building	Miami, Fla.	Generator	GM	3	1050	600	16	8½	10	2	E	S	....	.....
		Aux. Gen.	GM	1	225	1200	8	5½	7	4	E	S	....	.....
Purcell	Oklahoma	Mun. Gen.	FM	1	1050	300	6	16	20	2	A	S	0.37	960-D
Augusta	Kansas	Mun. Gen.	FM	1	1050	300	6	16	20	2	A	S	....	.....
Sleepy Eye	Minnesota	Mun. Gen.	FM	1	1050	300	6	16	20	2	A	S	....	.....
Jacksonville	Illinois	Mun. Gen.	FM	2	1050	300	6	16	20	2	A	S	....	.....
				1	875	300	5	16	20	2	A	S	....	.....
1000–600 hp per engine														
Texas Star Flour Mills	Galveston, Texas	Flour Mill	BuS	2	1000	277	8	14¾	18	2	A	A	....	.....
		Ind. Gen.	Bol	1	150	325	2	....	....	2	A	S	....	.....
Perry	Oklahoma	Mun. Gen.	FIW	1	1000	225	8	17½	24½	4	A	S	0.38	1200-D
Algona	Iowa	Mun. Gen.	FIW	1	1000	225	8	17½	24½	4	A	S	0.38	.....
Vernon	Texas	Mun. Gen.	Nord	1	1000	257	4	17	25	2	A	A	....	.....
Bryan	Texas	Mun. Gen.	BuS	1	1000	257	8	16¼	24½	4	A	A	0.41	2145-D
Wisconsin Power Cooperative	Chippewa Falls, Wis.	C. S. Gen.	BuS	2	1000	257	8	16¼	24½	4	A	S	0.38	3000-D
Wm. E. Hooper & Sons Co.	Baltimore, Md.	Ind. Gen.	ALC	1	950	214	8	17½	25	4	A	S	0.39	D
Central States Pipe Line Co.	Flora, Ill.	Oil Pump	ALC	1	900	264	6	17½	25	4	A	S	0.39	.....
Cozad	Nebraska	Mun. Gen.	FM	1	875	300	5	16	20	2	A	S	....	.....
Indianola	Iowa	Mun. Gen.	FM	1	875	300	5	16	20	2	A	S	0.39	1280-D
Cherokee	Oklahoma	Mun Gen.	BuS	1	875	300	5	15⅛	21	2	A	S	0.39	1060-D
Benson	Minnesota	Mun. Gen.	FM	1	875	300	5	16	20	2	A	S	....	900-S
				1	500	400	5	12	15	2	A	S	....	
Radford	Virginia	Mun. Gen.	ALC	1	860	257	6	17½	25	4	A	S	0.39	.....
Dowagiac	Michigan	Mun. Gen.	FM	1	805	300	7	14	17	2	A	S	....	1000-D
Robstown	Texas	Mun. Gen.	Sup §	1	760	300	8	14½	20	4	A	S	0.40	.....
				2	570	300	6	14½	20	4	A	S	0.40	.....
Madison	Minnesota	Mun. Gen.	Nord	2	750	257	3	17	25	2	A	S	....	.....
Bath	New York	Mun. Gen.	Sup §	1	750	327	8	14½	18	4	A	..	....	800-D
Anardarko	Oklahoma	Mun. Gen.	BuS	1	750	257	6	16¼	24½	4	A	S	0.38	860-D
Palmyra	Missouri	Mun. Gen.	ALC	1	730	257	5	17½	25	4	A	S	0.39	D
Fairview	Oklahoma	Mun. Gen.	FM	1	700	300	4	16	20	2	A	S	....	.....
Marlow	Oklahoma	Mun. Gen.	FM	1	700	300	4	16	20	2	A	S	0.37	950-D
Ellinwood	Kansas	Mun. Gen.	FM	1	700	300	4	16	20	2	A	S	....	.....
Plaquemine	Louisiana	Mun. Gen.	FM	1	700	400	7	12	15	2	A	S	....	.....
Coon Rapids	Iowa	Mun. Gen.	Wor	1	690	300	6	16	20	4	A	S	....	.....
Deshler	Ohio	Mun. Gen.	FM	1	690	300	6	14	17	2	A	S	....	.....
Zeeland	Michigan	Mun. Gen.	FM	1	690	300	6	14	17	2	A	S	....	750-D
Genesee Stone Products Corp.	Batavia, N. Y.	Ind. Gen.	Buc	1	675	400	8	9½	14	4	A	S	0.40	.....
New Madrid	Missouri	Mun. Gen.	Wor	1	625	327	6	16	20	4	A	S	....	.....
Gibsonburg Lime Prod. Co.	Gibsonburg, O.	Ind. Gen.	Sup	1	625	400	8	12½	16½	4	A	S	....	.....
Onawa	Iowa	Mun. Gen.	ALC	1	625	225	5	17½	25	4	A	S	0.39	1300-D
Paragould	Arkansas	Mun. Gen.	Sup	3	620	400	8	12½	16½	4	A	S	0.39	.....
Cordell	Oklahoma	Mun. Gen.	GM	1	600	277	..	....	....	2	A	..	0.39	950-D
Marlow	Oklahoma	Mun. Gen.	FM	1	600	250	4	....	....	2	A	..	0.37	950-D&G
Constantine	Michigan	Mun. Gen.	RJ	1	600	257	5	16	24	4	A	S	0.40	495-D
Refuge Cotton Oil Co.	Rosedale, Miss.	Cotton Mill	BuS	1	600	300	8	13	20	4	A	S	0.39	.....
Santee Mills	Orangeburg, S. C.	Cotton Mill	RJ	1	600	300	7	13¼	22	4	A	S	0.40	300-D
575–300 hp per engine														
Salem	Missouri	Mun. Gen.	FM	1	575	300	5	14	17	2	A	S	....	.....
So. Mich. REA Co-op	Blissfield, Mich.	C. S. Gen.	FM	2	575	300	5	14	17	2	A	S	....	.....
American Ice Co.	Long Island City, N. Y.	Ref.Comp.&Gen.	DLV	1	523	300	6	15	18½	4	A	S	0.43	550-D
Texas Co.	Salem, Ill.	Oil Pump	BuS	2	500	400	6	13	17	4	A	A	0.43	.....
Mora	Minnesota	Mun. Gen.	Wor	1	500	360	6	13¼	17½	4	A	S	....	.....
			FM	1	280	300	4	14	17	2	A	S	....	.....
			FM	1	210	300	3	14	17	2	A	S	....	.....
Mt. Sinai Hospital	New York, N. Y.	Generator	ALC	2	500	400	8	12½	13	4	A	S	0.40	700-S
Tri-County Electric Co-op	Eaton Rapids, Mich.	C. S. Gen.	Wor	2	500	360	6	13¼	17½	4	A	S	....	.....
Antioch College	Yellow Springs, Ohio	Generator	GM	1	450	720	6	8½	10	2	E	S	0.41	450-S
Vandalia	Missouri	Mun. Gen.	FM	3	450	300	6	14	17	2	A	S	0.39	.....
Remsen	Iowa	Mun. Gen.	Wor	1	450	327	6	13¼	17½	4	A	S	0.41	560-D
San Augustine	Texas	Mun. Gen.	FM	1	450	300	6	14	17	2	A	S	....	.....
Yuma	Colorado	Mun. Gen.	FM	1	450	300	6	14	17	2	A	S	....	.....
Columbia Quarry Co.	Valmeyer, Ill	Ind. Gen.	Sup	1	420	400	6	12½	15	4	A	S	....	.....
Odessa	Missouri	Mun. Gen.	Wor	2	415	360	5	13¼	17½	4	A	S	0.39	.....
Teague	Texas	Mun. Gen.	FM	1	375	300	5	14	17	2	A	S	0.39	540-D
Forest City	Iowa	Mun. Gen.	BuS	1	375	360	5	13	17	4	A	S	0.40	.....
				1	300	360	4	13	17	4	A	S	0.40	.....
				1	225	360	3	13	17	4	A	S	0.40	.....
St. Francis	Kansas	Mun. Gen.	FM	1	375	300	5	14	17	2	A	S	0.43	800-D
				1	225	300	3	14	17	2	A	S	0.43	
Milford	Iowa	Mun. Gen.	Wor	1	375	327	5	13¼	17½	4	A	S	....	.....
Waverly	Iowa	Mun. Gen.	Wor	1	375	360	5	13¼	17½	4	A	S	....	1250-D
Flandreau	South Dakota	Mun. Gen.	Wor	2	375	327	5	13¼	17½	4	A	S	0.41	750-D
Franklin	Nebraska	Mun. Gen.	FM	1	375	300	5	14	17	2	A	S	0.38	440-D
Sitka Cold Storage	Sitka, Alaska	Ind. Gen.	Ent.	1	360	450	6	11½	14	4	A	S	0.39	.....
Petersburg	Alaska	Mun. Gen.	Ent.	1	360	450	6	11½	14	4	A	S	0.39	.....
Charles Stone Co.	Chester, Ill.	Crusher	Sup	1	350	600	8	9	12	4	A	S	....	.....
Trinidad Asphalt Mfg. Co.	St. Louis, Mo.	Ind. Gen.	Sup	1	350	600	8	9	12	4	A	S	....	.....
Rohl-Connolly Co.	Los Angeles, Calif.	Ind. Gen.	Sup	1	350	600	8	9	12	4	A	S	....	.....
Electra	Texas	Mun. Gen.	Sup	4	350	400	5	12½	15	4	A	S	0.44	.....
U. S. Treasury Dept.	Alcatraz Island, Calif.	Generator	Ent	1	330	400	6	11½	14	4	A	S	0.39	.....
Standish Pipe Line Co.	Edgerton, Kan.	Pump	Sup	2	325	550	8	9	12	4	A	S	....	.....
Blanton Co.	St. Louis, Mo.	Ind. Gen.	Sup	1	325	375	5	12½	15	4	A	S	....	.....
U. S. Engineers	Omaha, Neb.	Dredge Pump	Ent	1	320	350	6	12	15	4	A	S	0.39	.....
		Generator	Ent	1	160	575	6	8	10	4	A	S	0.39	.....
Wagoner	Oklahoma	Mun. Gen.	VS*	1	300	327	4	14¼	16½	2	A	S	....	.....
Chelsea	Oklahoma	Mun. Gen.	FM	1	300	300	4	14	17	2	A	..	0.44	450-G

ABBREVIATIONS—ADE—Anderson Diesel Engine Co, ALC—American Locomotive Co, Bol—Bolinders, Buc—Buckeye, BuS—Busch-Sulzer, Cat—Caterpillar, CP—Chicago Pneumatic, DLV—De La Vergne, Ent—Enterprise Engine Co, FIW—Fulton Iron Works, FM—Fairbanks, Morse, GM—General Motors, LeR—LeRoi, Nord—Nordberg, PMC—Power Mfg Co, Reid—Jos. Reid Gas Engine Co, RJ—Rathbun-Jones, Sup—Superior (Nat. Supply Co), VS—Venn-Severin, Wauk—Waukesha, Wor—Worthington, Alt.—alternator, Comp—compressor, C.S.—central station, Gen—generator, Ind.—individual, Irrig.—irrigation, Mun.—municipal, Ref.—refrigeration.

Under other capacity, D is diesel, S is steam, G is gas. Under fuel injection, A is air, S is solid. Under starting method, A is air, E is electric, G is gasoline.

§ Convertible to gas. * Moderate-pressure oil engine. † Standard gas engine, with lowered compression ratio, burning No. 1 furnace oil. ‡ Hesselman engine.

Owner	Location	Equip. Driven	Engine Builder	No. Units	Hp Each	Rpm	No. Cyl	Cyl Bore	Cyl Stroke	Cycle	Starting Method	Fuel Injection	Fuel, lb per hp hr	Other capacity, hp, in same plant
Renwick	Iowa	Mun. Gen.	FM	1	300	300	4	14	17	2	A	S	....	240-D
Producers Gin	Safford, Ariz.	Cotton Gin	VS*	1	300	327	4	14¼	16½	2	A	S	....	....
Stuart	Iowa	Mun Gen.	FM	2	300	300	4	14	17	2	A	S	0.38	360-D
Washington	Kansas	Mun. Gen.	FM	1	300	300	4	14	17	2	A	S	0.44	....
				1	150	300	2	14	17	2	A	S	0.44	....
Princeton	Minnesota	Mun. Gen.	FM	1	300	300	4	14	17	2	A	S	....	....
				2	225	300	3	14	17	2	A	S	....	....
Corbin Brick Co	Corbin, Ky.	Lineshaft	Buc	1	300	400	8	9½	14	4	A	S	0.40	....
Portable Rig Co	Houston, Texas	Oil Drill	Wauk‡	2	300	900	6	8½	8½	4	E	S	0.52	....
Mike Jones	Eloy, Ariz.	Irrig. Pump	VS*	1	300	327	4	14¼	16½	2	A	S	....	....
Carroll Sand & Gravel Co	Clarence, N. Y.	Ind. Gen.	Buc	1	300	360	4	13½	15½	4	A	S	0.40	....
Girard	Pennsylvania	Mun. Gen.	FM	1	300	300	4	14	17	2	A	S	....	....
Truman	Minnesota	Mun. Gen.	Wor	2	300	400	6	10¾	14½	4	A	S	0.40	....
Primghar	Iowa	Mun. Gen.	BuS	1	300	360	4	13	17	4	A	S	0.40	....
				1	225	360	3	13	17	4	A	S	0.40	....
La Plata	Missouri	Mun. Gen.	FM	2	300	300	4	14	17	2	A	S	0.38	....
Westbrook	Minnesota	Mun. Gen.	FM	1	300	300	4	13	17	2	A	S	0.42	....
				1	225	300	3	13	17	2	A	S	0.42	....
Tyndall	South Dakota	Mun. Gen.	FM	1	300	300	4	14	17	2	A	S	....	....
Navajo Indian Agency	Window Rock, Ariz.	Generator	FM	1	300	300	4	14	17	2	A	S	....	....
Southern Flour Mills	Albemarle, N. C.	Ind. Gen.	Buc	1	300	400	8	9½	14	4	A	S	0.40	....
Pontiac Stone Co	Princeville, Ill.	Ind. Gen.	VS*	1	300	327	4	14¼	16½	2	A	S	....	....
Paris	Missouri	Mun. Gen.	FM	1	300	300	4	14	17	2	A	S	....	....
M. D. King Milling Co	Pittsfield, Ill.	Ind. Gen.	FM	1	300	300	4	14	17	2	A	S	....	....
Cranberry Mfg. Co	Galax, Va.	Ind. Gen.	Buc	1	300	400	8	9½	14	4	A	S	0.40	....
				1	225	400	6	9½	14	4	A	S	0.40	....
Lamoni	Iowa	Mun. Gen.	FM	2	300	300	4	14	17	2	A	S	....	....
280–180 hp per engine														
Ferris & Marchbank	John Day, Oregon	Dredge Pump	FM	1	280	720	8	8	10½	4	A	S	....	....
St. Josephs Hospital	Kansas City, Mo.	Generator	FM	1	280	720	8	8	10½	4	A	S	....	....
Caldwell Stone Co	Danville, Ky.	Ind. Gen.	Buc	1	262½	400	7	9½	14	4	A	S	0.40	....
Lofland Bros	Oklahoma City, Okla.	Drill	Sup	1	260	600	6	9	12	4	A	S	....	....
Rockport	Missouri	Mun. Gen.	ADE	3	240	300	4	12½	18	2	A	S	0.43	....
Burlington	Kansas	Mun. Gen.	FM	1	225	300	3	14	17	2	A	S	....	....
Upton Cold Storage	Rochester, N. Y.	Ind. Gen.	Sup	1	225	514	6	9	12	4	A	S	....	....
Sanger	Texas	Mun. Gen.	FM	1	225	300	3	14	17	2	A	S	....	....
Itta Bena	Mississippi	Mun. Gen.	FM	1	225	300	3	14	17	2	A	S	0.39	175-D
Koehnline Ice & Storage Co	Bellaire, Ohio	Ref. Comp.	FM	1	225	300	3	14	17	2	A	S	....	....
		Ind. Gen.	FM	1	120	360	2	12	15					
Mulvane	Kansas	Mun. Gen.	FM	1	225	300	3	14	17	2	A	S	....	....
Thayer	Missouri	Mun. Gen.	FM	2	225	300	3	14	17	2	A	S	0.39	....
Second Jefferson Drainage Dist	Marrero, La.	Drainage Pump	FM	1	225	300	3	14	17	2	A	S	....	....
A. A. Mantey Alfalfa Mill	Alma, Mich.	Ind. Gen.	Buc	1	225	400	6	9½	14	4	A	S	0.40	....
Clay Electric Co-op Assn	Keystone Heights, Fla.	C. S. Gen.	Sup	2	225	514	6	9	12	4	A	S	....	....
Lathrop	Missouri	Mun. Gen.	FM	1	225	300	3	14	17	2	A	S	0.39	....
				1	150	300	2	14	17	2	A	S	0.39	....
U. S. Envelope Co	Indianapolis, Ind.	Ind. Gen.	Buc	1	225	400	6	9½	14	4	A	S	0.40	....
Cal. Inst. Technology	Pasadena, Calif.	Generator	Ent	1	225	450	6	10	13	4	A	S	0.39	240-D
Giessing Mill Co	Farmington, Mo.	Flour Mill	VS*	1	200	300	3	14¼	16½	2	A	S	....	....
Bear Rock Mining Co	Patton, Pa.	Ind. Gen.	Buc	1	190	240	2	16	20	2	A	S	0.50	....
Miami Oolite Rock Co	Miami, Fla.	Rock Crusher	Wauk ‡	1	190	1050	6	7	7	4	E	S	0.55	....
Jahncke Service, Inc	New Orleans, La.	Mat. Hdlg. Eq.	Wauk ‡	1	190	1050	6	7	7	4	E	S	0.53	....
W. W. Clyde Const. Co	Springville, Utah	Asphalt Plant	Wauk ‡	1	190	1050	6	7	7	4	E	S	0.55	....
North Pole Ice Co	Tampa, Fla.	Ref. Comp.	Buc	1	187½	400	5	9½	14	4	A	S	0.40	....
City Ice Co	Rocky Mount, N. C.	Alternator	Buc	1	187½	400	5	9½	14	4	A	S	0.40	....
Beach Haven Ice & Cold Storage Co.	Beach Haven, N. J.	Ref.Comp.&Gen.	FM	1	180	360	3	12	15	2	A	S	....	....
Northern Gravel Co	Muscatine, Iowa	Pump	Sup	1	180	420	6	9	12	4	A	S	....	....
McKinzey Milling Co	Quincy, Mich.	Ind. Gen.	ADE	1	180	300	3	14	18	2	A	S	0.43	....
Elmes Engrg. Works	Chicago, Ill.	Ind. Gen.	FM	1	180	360	3	12	15	2	A	S	....	....
170–110 hp per engine														
Farmers Gin Co	Round Pond, Ark.	Cotton Gin	LeR †	1	170	900	6	6¾	7	4	..	S	....	....
V. E. Emanuel	Baton Rouge, La.	Mat. Hdlg. Eq.	Wauk ‡	1	165	1050	6	6½	7	4	E	S	0.51	....
Delaware Clay Co	Delaware, Ohio	Ind. Gen	PMC	2	165	230	1	22	24	2	A	S	....	....
Rosebud Indian Agency	Rosebud, S. D.	Generator	Sup	1	163	400	5	9	12	4	A	S	....	....
Air Blast Gin	Abbott, Tex.	Cotton Gin	Cat	1	160	850	8	5¾	8	4	G	S	0.44	....
French Henry Mining Co	Ute Park, N. M.	Ind. Gen.	Cat	1	160	850	8	5¾	8	4	G	S	0.43	....
Consumers Steel & Supply Co	Racine, Wis.	Hydr. Pump	Cat	1	160	850	8	5¾	8	4	G	S	0.44	....
Vermiculite Co. of America	Minneapolis, Minn.	Ind. Gen.	Cat	1	160	850	8	5¾	8	4	G	S	0.43	....
Frick Reid Supply Corp	Odessa, Texas	Drill	Reid	2	150	325	2	13¼	16	2	A	S	0.42	....
St. Charles	Missouri	Mun. Gen.	FM	3	150	300	2	14	17	2	A	S	....	....
Conn. College	New London, Conn.	Generator	DLV	2	150	514	6	9	12	4	A	S	0.41	450-S
Mt. Olive Milling Co	Mt. Olive, Ill.	Flour Mill	VS*	1	150	300	3	12¼	13½	2	A	S	....	....
Consumers Ice Co	Decatur, Ill.	Ref.Comp.&Gen.	FM	2	150	300	2	14	17	2	A	S	....	....
Chitwood Packing Co	McCook, Neb.	Ind. Gen.	VS*	1	150	327	3	12¼	13½	2	A	S	....	....
			VS*	1	100	327	2	12¼	13½	2	A	S	....	....
Randolph	Nebraska	Mun. Gen.	FM	1	150	300	2	14	17	2	A	S	0.38	300-D
Swayze Folding Box Co	Canton, Pa.	Ind. Gen.	Buc	1	150	400	4	9½	14	4	A	S	0.40	....
Ashland Refining Co	Catlettsburg, Ky.	Pump	Reid	1	140	300	2	13¼	16	2	A	S	0.42	....
Pioneer Elevator Co	Pioneer, Ohio	Ind. Gen.	ADE	1	140	300	4	10	14	2	A	S	0.43	....
White Dove Flour Mills	New Athens, Ill.	Flour Mill	VS*	1	140	327	2	14¼	16½	2	A	S	....	....
Emil Kirchenman	Shafter, Calif.	Irrig. Pump	VS*	1	140	327	2	14¼	16½	2	A	S	....	....
Hiram	Ohio	Mun. Gen.	ADE	1	140	300	2	14	18	2	A	S	0.43	....
				2	120	300	2	12½	18	2	A	S	0.43	....
Henderson Co. Drain. Dist. Nos. 1-2	Henderson Co., Ill.	Water Pumps	Cat	4	135	950	8	5¾	8	4	G	S	0.43	....
Western Electric Co	Cleveland, Ohio	Aux. Gen.	Sup	2	135	720	6	7	9	4	A	S	....	....
Springfield	Massachusetts	Mun. Pump	Sup	2	130	600	3	9	12	4	A	S	....	....
Dooley Electric Co	New York, N. Y.	Generator	Sup	1	130	600	3	9	12	4	A	S	....	....
Gillespie Land & Irrig. Co	Gila Bend, Ariz.	Water Pump	Sup	5	130	600	3	9	12	4	A	S	....	D
Sandhill Furniture	West End, N. C.	Ind. Gen.	VS*	1	130	300	2	14¼	16½	2	A	S	....	....
Diesel Electric Co., Inc	New York, N. Y.	Ind. Gen.	Sup	2	130	600	3	9	12	4	A	S	....	....
J. W. Mortell Co	Kankakee, Ill.	Ind. Gen.	Cat	2	125	850	6	5¾	8	4	G	S	0.44	....
Irwinsville Co-op. Assn	Irwinville, Ga.	Cotton Gin	Cat	1	125	850	6	5¾	8	4	G	S	0.44	....
Chester Todd	Ludlow, Calif.	Air Comp.	PMC	1	125	260	2	14½	17	2	A	S	....	....
J. H. Dogan & Sons Gin Co	Charleston, Miss.	Cotton Gin	Cat	1	125	850	6	5¾	8	4	G	S	0.44	....
Batesburg Ice Plant	Batesburg, S. C.	Ref. Comp. & Ind. Gen.	Cat	1	125	850	6	5¾	8	4	G	S	0.44	....
Arnim Gin Co. No. 1	Corpus Christi, Tex.	Cotton Gin	Buc	1	125	200	1	19	23	2	A	S	0.50	....
Magnolia Petroleum Co	Salem, Ill.	Oil Pump	Cat	1	125	850	6	5¾	8	4	G	S	0.44	....
Haywire Mining & Milling	Bonners Ferry, Idaho	Mine Shaft	Cat	1	125	850	6	5¾	8	4	G	S	0.44	....
St. John Bosco Mines	Crescent City, Calif.	Ind. Gen.	Cat	1	125	850	6	5¾	8	4	G	S	0.44	....
Individual Laundry	Stamford, Conn.	Ind. Gen.	VS*	1	120	400	4	10½	12	2	A	S	....	....
Carrie Tingley Hospital	Hot Springs, N. Mex.	Generator	FM	1	120	360	2	12	15	2	A	S	....	....
Farmers Gin Co	Pace, Miss.	Cotton Gin	FM	1	120	360	2	12	15	2	A	S	....	....
W. V. Griffe Gin	Woodson, Ark.	Cotton Gin	LeR †	1	120	900	4	6¾	7	4	..	S	....	....
Gainesville Supply Co	Mason, Tenn.	Cotton Gin	LeR †	1	120	900	4	6¾	7	4	..	S	....	....
Dry Fork Milling Co	Dry Fork, Va.	Mill	FM	1	120	360	2	12	15	2	A	S	....	....
Crowley Feed Co	San Antonio, Tex.	Ind. Gen.	FM	1	120	360	2	12	15	2	A	S	....	....
Witherington & Hall Gin	Covington, Tenn.	Cotton Gin	LeR †	1	120	900	4	6¾	7	4	..	S	....	....
Benziger Bros	Brooklyn, N. Y.	Ind. Gen.	FM	1	120	257	2	14	17	2	A	S	0.45	....
Charleston Gin Co	Stanton, Tenn.	Cotton Gin	LeR †	1	120	900	4	6¾	7	4	..	S	....	....
Neptune Twine & Cord Mills	Moodus, Conn.	Ind. Gen.	FM	1	120	360	2	12	15	2	A	S	....	....
Stevens Pure Ice Co	Torrington, Conn.	Ref. Comp.	CP	1	120	600	4	....	....	4	A	S	....	267-D
French Sardine Co	Terminal Island, Calif.	Ind. Gen.	Ent	1	115	550	4	8	10	4	A	S	0.39	....
				1	85	575	3	8	10	4	A	S	0.39	....
Gibble & Ebling	Bethel, Pa.	Flour Mill	Sup	1	115	700	5	7	9	4	A	S	....	....
Asbury College	Wilmore, Ky.	Generator	Sup	2	115	720	5	7	9	4	A	S	....	....
Burke	South Dakota	Mun. Gen.	Buc	1	112½	400	3	9½	14	4	A	S	0.40	....
Great Southern Hotel	Gulfport, Miss.	Alternator	Buc	2	112½	400	3	9½	14	4	A	S	0.40	....
Comfort Brick & Tile Co	Tecumseh, Mich.	Lineshaft	Buc	1	112½	400	3	9½	14	4	A	S	0.40	....
Gibson Ice Co	Muncie, Ind.	Ref. Comp.	Buc	1	112½	400	3	9½	14	4	A	S	0.40	....
Pantorium, Inc	Dayton, Ohio	Ind. Gen.	Buc	1	112½	400	3	9½	14	4	A	S	0.40	....
Catawba County Ice & Fuel Co	Newton, N. C.	Ref. Comp.	Buc	1	112½	400	3	9½	14	4	A	S	0.40	....
Ingersoll-Rand Co	Painted Post, N. Y.	Air Comps.	Wauk ‡	36	110	950	4	6½	8	4	E	S	0.54	....

Diesel Installations 100 Hp and Under

Owner	Location	Equipt. driven	Engine builder	No. units	Hp each	Rpm	No. cyl	Bore	Stroke	Starting method
Natchegall Mfg Co, Grand Rapids, Mich.		Shaft	Buc	1	100	514	5	7⅛	10½	A
Geo C King, Shingler, Ga.		Gin	VS*	1	100†	327	2	12¼	13½	A
M & G Zanovich, Delano, Calif.		Pump	VS*	1	100†	327	2	12¼	13½	A
South Superior, Wyoming		Gen.	Cat	1	100	850	6	5¼	8	G
Model Mills, McLeansboro, Ill.		Mill	VS*	1	100†	327	2	12¼	13½	A
Gen Petroleum Corp, San Diego, Calif.		Pump	Ent	2	100	330	4	10	13	A
Getmann & Judd, Stamford, Conn.		Lathe	VS*	1	100†	327	2	12¼	13½	A
Jack Radovich, Delano, Calif.		Pump	VS*	1	100†	327	2	12¼	13½	A
Center Val Coop Assn, Black Cr, Wis.		Mill	Buc	1	100	514	5	7⅛	10½	A
Weis Packing Co, Maysville, Ky.		Gen.	Buc	1	100	514	5	7⅛	10½	A
Larchwood, Iowa		Gen.	FM	1	100†	450	3	8¾	10½	A
Sanacori & Co, Brooklyn, N. Y.		{Gen.	VS*	1	100†	327	2	12¼	13½	A
		{Gen.	VS*	1	40†	650	2	7	8	A
American Service Co, Neodesha, Kan.		Gen.	VS*	1	100†	327	2	12¼	13½	A
Canal Barge Co, New Orleans, La.		Pump	Wauk‡	1	95	1500	6	4⅝	5⅛	E
Chase Turbine Co, Orange, Mass.		Saw	Wauk‡	2	90	1050	4	6	6½	E
Dacotah Hotel, Grand Forks, N.D.		Gen.	FM	2	90†	450	3	8¾	10½	A
America n Service Co, Kansas City, Mo.		Comp.	FM	1	90†	450	3	8¾	10½	A
Geo. Tregre, Port Allen, La.		Pump	Wauk‡	1	90	900	4	6	6½	E
C'wealth Clr & Chem Co, Bklyn, N.Y.		Gen.	Mod	1	90†	600	3	6	10⅝	A
Barber Bros Const Co, Mathiston, Miss.		Gen.	GM	1	90†	1200	6	4¼	5	E
Denison Peanut Co, Denison, Texas.		Gen.	GM	3	90†	1200	6	4¼	5	E
L P Davis Const Co, Chalmette, La.		.....	Wauk‡	1	90	950	4	6	6½	E
Lambeth Rope Co, New Bedford, Mass.		Gen.	GM	1	90†	1200	6	4¼	5	E
Bay Refining Co, Bay City, Mich.		Gen.	GM	3	90†	1200	6	4¼	5	E
Thomas Laughlin Co, Portland, Me.		Gen.	GM	5	90†	1200	6	4¼	5	E
Campbells Feed M, Bloom. Pr, Minn.		Mill	GM	1	90†	1200	6	4¼	5	E
Modern Ice Co, Dalton, Ga.		Comp.	GM	1	90†	1200	6	4¼	5	E
Gilbrech Plantation, Palmer, Ark.		Gin	GM	1	90†	1200	6	4¼	5	E
Ringling Bros Circus, Sarasota, Fla.		Gen.	GM	{5	90†	1200	6	4¼	5	E
				{1	45†	1200	3	4¼	5	E
R G LeTourneau Inc, Toccoa, Ga.		Gen.	GM	1	90†	1200	6	4¼	5	E
Ingersoll-Rand Co, Painted Post, N.Y.		{Comp.	Wauk‡	23	90	1050	4	6	6½	E
		{Pump	Wauk‡	5	90	1050	4	6	6½	E
Union Pacific RR, Omaha, Neb.		Gen.	GM	3	90†	1200	6	4¼	5	E
Boyd Milling Co, Boyd, Wis.		Gen.	FM	1	90†	450	3	8¾	10½	A
Socony-Vacuum Oil Co, St. Louis, Mo.		Pump	Sup	1	86	650	4	7	9	A
Florida Shrimp Co, Jacksonville, Fla.		.....	Wauk‡	1	85	1050	4	6	6½	E
W W Clyde Const Co, Springville, Utah		Crane	Wauk‡	1	85	1050	4	6	6½	E
Standard Fisheries, Jacksonville, Fla.		Comp.	Wauk‡	1	85	1050	4	6	6½	E
Grand Fish Co, Jacksonville, Fla.		.....	Wauk‡	2	85	1050	4	6	6½	E
Wis. Fndry & Mach Co, Madison, Wis.		Comp.	Wauk	1	85	1050	4	6	6½	E
Mech Equipt Co, New Orleans, La.		{Comp.	Wauk‡	1	85	1050	4	6	6½	E
		{Pump	Wauk‡	1	65	1600	6	3¾	4¼	A
L & F McGinnis, Rondo, Ark.		Gin	PMC	1	85†	300	1	15	20	A

80–60 hp per engine

Fine Arts Furn. Co, G. Rapids, Mich.		Shaft	Buc	1	80	514	4	7⅛	10½	A
Michigan Cleaners, Chicago, Ill.		Gen.	VS*	1	80†	300	2	12¼	13½	A
Pond Village C S Co, N. Truro, Mass.		Comp.	Cat	2	80	850	4	5¾	8	G
Grfld Ice & Coal Co, Greenfield, Tenn.		Comp.	Buc	1	80	514	4	7⅛	10½	A
Stiles Inc, Grand Rapids, Mich.		Gen.	Buc	1	80	514	4	7⅛	10½	A
Georgetown Ice Co, Georgetown, S.C.		Comp.	Buc	1	80	514	4	7⅛	10½	A
LaValle Mill & Elect, LaValle, Wis.		Gen.	Buc	1	80	514	4	7⅛	10½	A
Crystal Ice Co, Charleston, S.C.		Comp.	Buc	1	80	514	4	7⅛	10½	A
Heine Bros Packing Co, Logan, Ohio.		Gen.	Buc	1	80	514	4	7⅛	10½	A
Wimber Knob Coal Co, Windber, Pa.		Gen.	Cat	1	80	850	4	5¾	8	G
Brewer & Brewer Sons, Chillicothe, O.		Pump	Cat	1	80	850	4	5¾	8	G
White Villa Grocers, Dayton, Ohio.		Gen.	Buc	1	80	514	4	7⅛	10½	A
Camp'ville Ice Co, Campbellsville, Ky.		Comp.	Buc	1	75	400	2	9½	14	A
La. Materials Co, New Orleans, La.		.....	Wauk‡	2	75	1800	6	3¾	4¼	E
Platzl Restaurant, New York, N.Y.		Gen.	MAN	1	72	720	3	6.88	8.66	A
Emporia Ice Co, Emporia, Va.		Comp.	PMC	1	70†	277	1	16	18	A
Midwest Refineries, Alma, Mich.		{Pump	Reid	1	70†	332	2	10¼	12	A
		{Pump	Reid	1	43†	325	1	10¾	14	A
		{Pump	Reid	1	25†	275	1	10¼	12	A
Slaton, Texas		Pump	Cat	1	66	1400	6	4¼	5½	G
Ingersoll-Rand Co, Painted Post, N.Y.		Comp.	Wauk‡	26	65	1050	4	5	6½	E
Harnischfeger Corp, Milwaukee, Wis.		Gen.	Wauk‡	5	65	1600	6	3¾	4¼	H
Jaeger Restaurant, New York, N.Y.		Gen.	MAN	2	65	900	6	4.7	7.0	A
C S Ward, Jacksonville, Fla.		Gen.	GM	1	60†	1200	4	4¼	5	E
Int'l Harvester Co, Chicago, Ill.		Gen.	GM	1	60†	1200	4	4¼	5	E
M O Ranch, Kerrville, Texas		Gen.	GM	1	60†	1200	4	4¼	5	E
Troy Aggregates Co, Detroit		Pump	GM	1	60†	1200	4	4¼	5	E
Ctrpllr Tractor Co, Peoria, Ill.		Gen.	GM	1	60†	1200	4	4¼	5	E
Standard Oil Co, Richmond, Calif.		Dyn.	GM	1	60†	1200	4	4¼	5	E
L W Spengler, Hartsook, Calif.		Gen.	Cat	1	60	850	3	5¾	8	G
G E Falliing Supply Co, Enid, Okla.		Drill	GM	{1	60†	1200	4	4¼	5	E
				{1	45†	1200	3	4¼	5	E
Langley Lt & Pwr Co, Langley, Okla.		Gen.	GM	1	60†	1200	4	4¼	5	E
H D Grundt, Wasco, Calif.		Pump	VS*	1	60†	300	1	14¼	16½	A
Magee Garage, E Bloomsburg, Pa.		Gen.	GM	2	60†	1200	4	4¼	5	E
Hartford, Conn.		Saw	GM	1	60†	1200	4	4¼	5	E
Nflk Paint Co, Norfolk Downs, Mass.		Gen.	GM	{1	60†	1200	4	4¼	5	E
				{1	45†	1200	3	4¼	5	E
Morgantown Grain Co, Mgtown, Ind.		Gen.	Buc	1	60	514	3	7⅛	10½	A
Antioch Packing Co, Antioch, Ill.		Gen.	VS*	1	60†	400	2	10½	12	A
Kligerman Dairies, Atlantic City, N.J.		Gen.	ADE	1	60†	277	2	10	14	A
W W Holmes, Delano, Calif.		Pump	VS*	1	60†	300	1	14¼	16½	A
Eagle Rule Mfg Co, Bronx, N.Y.		Gen.	VS*	1	60†	400	2	10½	12	A
Lone Pine Mine, Golden, Idaho		Comp.	GM	1	60†	1200	4	4¼	5	E
Hill Top Pack Co, Huntingburg, Ind.		Gen.	Buc	1	60	514	3	7⅛	10½	A
J D Woods, Brookshire, Texas		Pump	GM	1	60†	1200	4	4¼	5	E
Monitor Roller Mills, Walnut Cove, N.C.		Gen.	Buc	1	60	514	3	7⅛	10½	A
Triple X Placer Co, Ferry, Alaska		Dredge	GM	1	60†	1200	4	4¼	5	E
Penns Grove Water Co, Penns Gr, N.J.		Pump	FM	1	60	1200	6	4¼	6	E
Rugby Creamery Co, Rugby, N.D.		Gen.	FM	1	60†	450	2	8¾	10½	A
CoveyGas&OilCo, LittleAmrca, Wyo.		Gen.	Cat	1	60	850	3	5¾	8	G
A G Vannote, Pierson, Fla.		Comp.	Buc	1	60	514	3	7⅛	10½	A
W Volusia Ice & CS Co, Pierson, Fla.		Comp.	Buc	1	60	514	3	7⅛	10½	A
Al & Lester Miller, Lancaster, Calif.		Pump	VS*	1	60†	300	1	14¼	16½	A
Lakeside Lt & Pwr Co, Lakeside, Ariz.		Gen.	Buc	1	60	514	3	7⅛	10½	A
L M Lockhart, Hinkley, Calif.		Pump	{VS*	1	60†	300	1	14¼	16½	A
			{VS*	1	40†	300	1	12¼	13½	A
Pure Ice & CS Co, Lake Charles, La.		Comp.	FM	1	60†	450	2	8¾	10½	A
Princeton, Maine		Gen.	FM	2	60†	450	2	8¾	10½	A

55–30 hp per engine

Dunn & Mallin, Stanley, Idaho		Comp.	Wauk‡	1	55	1400	4	4⅝	5¼	E
Ingersoll-Rand Co, Painted Post, N.Y.		Comp.	Wauk‡	263	55	1400	4	4⅜	5¼	E
Silver Trad Mining Co, Murphy, Idaho		Comp.	Wauk‡	1	55	1400	4	4⅜	5¼	E
76 W 86th St, New York, N.Y.		Gen.	Bud	1	55	1200	6	4½	5½	E
H L Green Co, New York, N.Y.		Gen.	Blk	1	50	450	1	10	14	A
Waxed Products Co, Plainfield, N.J.		{Gen.	Blk	2	50	450	1	10	14	A
		{Comp.	Blk	1	37	500	1	8¾	13	A
Rogers Jewelry Co, Cambridge, Mass.		Gen.	{GM	1	45†	1200	3	4¼	5	A
			{Bud	1	22	1200	4	3⅝	4¾	E
Socony-Vacuum Oil Co, Paulsboro, N.J.		Gen.	GM	1	45†	1200	3	4¼	5	E
Virginia Military Inst, Lexington, Va.		Dyn.	GM	1	45†	1200	3	4¼	5	E
E A Julien, Turlock, Calif.		.....	GM	1	45†	1200	3	4¼	5	E
Y D Markson, Lewiston, Me.		Gen.	GM	1	45†	1200	3	4¼	5	E
T C Wilcox, Carizzo Springs, Texas		Pump	GM	1	45†	1200	3	4¼	5	E
Downtown Chevrolet Co, Tulsa, Okla.		Gen.	GM	2	45†	1200	3	4¼	5	E
Univ. of Pa., Philadelphia, Pa.		Gen.	GM	1	45†	1200	3	4¼	5	E
Tidewater Oil Co, Bayonne, N. J.		Gen.	GM	1	45†	1200	3	4¼	5	E
Wilmington Cold Strge, Wilm'n, N.C.		Comp.	GM	1	45†	1200	3	4¼	5	E
Watson Sand & Gravel Co, Fluker, La.		Gen.	GM	2	45†	1200	3	4¼	5	E
Timken Bearing Co, Canton, Ohio.		Gen.	GM	1	45†	1200	3	4¼	5	E
Texas Co, Glenham, N.Y.		Gen.	GM	1	45†	1200	3	4¼	5	E
D W McKee, Wilmington, N.C.		Comp.	GM	1	45†	1200	3	4¼	5	E
R E Miller, Fort Morgan, Colo.		Pump	GM	1	45†	1200	3	4¼	5	E
Union Oil Co, Wilmington, Calif.		Gen.	GM	1	45†	1200	3	4¼	5	E
Continental Oil Co, Ponca City, Okla.		Gen.	GM	1	45†	1200	3	4¼	5	E
Citizens Ice Co, Vero Beach, Fla.		Comp.	GM	1	45†	1200	3	4¼	5	E
Bondurant Gold Mine, Coulterville, Cal.		Gen.	GM	1	45†	1200	3	4¼	5	E
Atlantic Refining Co, Philadelphia, Pa.		Gen.	GM	1	45†	1200	3	4¼	5	E
Popkin Bros, Inc, Trenton, N.J.		Comp.	GM	1	45†	1200	3	4¼	5	E
J J Jaegger, Hot Springs, N.Mex.		Gen.	GM	1	45†	1200	3	4¼	5	E
Beaubien Ice Co, Detroit, Mich.		Comp.	GM	1	45†	1200	3	4¼	5	E
Liberty Mfg Co, Red Springs, N.C.		Mill	GM	1	45†	1200	3	4¼	5	E
Standard Oil Co, Whiting, Ind.		Gen.	GM	1	45†	1200	3	4¼	5	E
J N Beattie, Ellerson, Va.		Mill	PMC	1	45†	300	1	13	16	A
Phillip Colli, Willits, Calif.		Gen.	Cat	1	44	1400	4	4¼	5½	G
J W Mortell Co, Kankakee, Ill.		Gen.	Cat	1	44	1400	4	4¼	5½	G
Ralph A Gardner, Easton, Mass.		Shaft	Cat	1	44	1400	4	4¼	5½	G
Julius Lewis, Memphis, Tenn.		Gen.	Cat	1	44	1400	4	4¼	5½	G
Kelley & Rabaleati, Eureka, Nev.		Gen.	Cat	2	44	1400	4	4¼	5½	G
Charles Kannel, E Stroudsburg, Pa.		Gen.	Buc	1	40	514	2	7⅛	10½	A
Colonial Inn, Singac, N.Y.		Gen.	Lis	1	40	1200	4	4½	5½	H
Excel Battery & Equipt, Chicago, Ill.		Gen.	VS*	1	40†	650	2	7	8	A
Johnston Livingston, Empress, Ga.		Gen.	Lis	{1	40	1200	4	4½	5½	H
				{1	21	1200	2	4½	5½	H
Peoples Packing Pl, Silver City, N.M.		Comp.	FM	1	40	1200	4	4¼	6	E
Allis-Chalmers Mf Co, Milwaukee, Wis.		.....	Lis	1	40	1200	4	4½	5½	H
John Randolf Hopkins, Cambridge, Md.		Gen.	Lis	1	40	1200	4	4½	5½	H
Graham Canal Co, Safford, Ariz.		Pump	FM	4	40	1200	4	4¼	6	E
Cape Charles, Virginia		Pump	Buc	1	40	514	2	7⅛	10½	A
Bredenhoft & Ball Co, Danville, Ill.		Gen.	VS*	1	40†	300	1	12¼	13½	A
Essex Transport Co, New York, N.Y.		Gen.	FM	2	40	1200	4	4¼	6	E
Mt. Pleasant Ice Cr Co, Thornwood, N.Y.		Comp.	Blk	1	37	500	1	8¾	13	A
Maxhams Fur Farm, Worcester, Vt.		Gen.	Blk	1	37	500	1	8¾	13	A
Hillman's, North Attleboro, Mass.		Shaft	Blk	2	37	500	1	8¾	13	A
Culinarts Products Co, Chicago, Ill.		Shaft	Wauk‡	1	36	1800	4	3⅝	4½	E
Ingersoll-Rand Co, Painted Post, N.Y.		Comp.	Wauk‡	62	35	1500	4	3¾	4¾	H
F Reid Sup Corp, Mt. Pleasant, Mich.		Drill	Reid	1	35†	350	1	10¼	12	A
Joe's Restaurant, Schenectady, N.Y.		Gen.	Rus	1	34	310	1	9¼	17½	A
C A Richter, Taytonville, Calif.		Gen.	Cat	1	32	1525	4	3¾	5	G
Crystal Ice & Fuel Co, Union, Mo.		Pump	VS*	1	30†	360	1	10½	12	A
Metrop. Ramp Garage, Hartford, Conn.		Gen.	Lis	1	30	1200	3	4½	5½	H
The Spinning Wheel, R'd'g Ridge, Conn.		Gen.	FM	1	30	1200	3	4¼	6	E
Oak Ridge Buick Co, Tuckahoe, N.Y.		Gen.	Mod	1	30†	600	1	6	10⅜	A
Namm Warehouse, Brooklyn, N.Y.		Gen.	Bud	1	30	1200	6	3½	4¾	E
Point O'Woods Assn, Pt O'Woods, N.Y.		Gen.	Lis	1	30	1200	3	4½	5½	H
Paulding Milling Co, Paulding, Ohio.		Mill	VS*	1	30†	400	1	10½	12	A
Auto Hotel Co, Cincinnati, Ohio.		Gen.	FM	{1	30	1200	3	4¼	6	H
				{1	20	1200	2	4¼	6	H
Gulf Fruit & Veg Co, Weslaco, Texas.		Shaft]	FM	1	30	1200	3	4¼	6	E
Silver Fleet Motor Express, Chicago.		Gen.	VS*	1	30†	400	1	10½	12	A
Harold Strogoff, Malden, Mass.		Crush.	FM	1	30	1200	3	4¼	6	E
Fish & Game Dept, Minnesota		Pump	FM	1	30	1200	3	4¼	6	E

Under 30 hp per engine

McClanahan Refinery, St. Louis, Mich.		Comp.	Reid	1	29†	275	1	10¼	12	A
Kohler Co, Kohler, Wis.		Gen.	{Wauk	24	25	1500	4	3¾	4¾	E
			{Lis	1	8	1200	1	4⅜	5½	H
Dept of Justice, Washington, D.C.		Gen.	Bud	1	25	1800	4	3⅜	4¾	E
Wilkins Bros, Hillsboro, Ohio.		Mill	PMC	1	25†	327	1	10	13½	A
Leonard Refinery, Alma, Mich.		Comp	Reid	1	23†	275	1	9	12	A
Salinger Store, Lowell, Mass.		Gen.	Blk	1	22	600	1	7¼	9½	A
Marg't Emerson, Racquette Lake, N.Y.		Gen.	Lis	1	21	1200	2	4½	5½	H
U.S. Ham'd Piston R. Co, Sterling, N.J.		Gen.	Bud	1	20	1200	4	3⅜	4¾	E
Markson Bros, Boston, Mass.		Gen.	Bud	1	20	1200	4	3⅜	4¾	E
United Tyre Sales Co, Waterbury, Conn.		Gen.	Lis	1	18	1000	2	4½	5½	H
Schoentag's Hotel, Saugerties, N.Y.		Gen.	Rus	1	17	360	1	7½	13½	H
Calmes Engine Co, New Orleans, La.		Gen.	Lis	3	16	1200	2	4⅜	5½	H
Frank Bauer, Jr, Cresskil, N.J.		Gen.	Jaen	2	16	1100	1	5.6	7.9	H
Bergen Oil Heating Co, Englewood, N.J.		Gen.	Sen	2	15	800	1	5.5	7.8	H
R Oerter, San Antonio, Texas.		Gen.	Sen	2	15	800	1	5.5	7.8	H
Scanlon Estate, Houston, Texas.		Gen.	GM	2	15†	1200	1	4¼	5	E
Tidewater Oil Co, Delano, Calif.		Gen.	GM	1	15†	1200	1	4¼	5	E
Athos Longo, Medford, Mass.		Gen.	GM	1	15†	1200	1	4¼	5	E
Kenneth Roberts, Kennebunk, Me.		Gen.	Lis	1	12	650	2	4½	5½	H
Philip Steir, New York, N.Y.		Gen.	Lis	2	12	650	2	4½	5½	H
Manor Pharmacy, Pelham Manor, N.Y.		Gen.	Lis	{1	12	650	2	4½	5½	H
				{1	6	650	1	4½	5½	H
Valley Garage, Palmer, Mass.		Gen.	Lis	1	12	650	2	4½	5½	H
Crofton Diesel Co, San Diego, Calif.		Gen.	Lis	2	6	650	1	4½	5½	H
Austin Linen Co, Boston, Mass.		Gen.	Str	1	5	1000	1	3⅞	4	H
Wharf Mach & Elect Co. Boston, Mass.		Pump	Lis	1	3½	650	1	3¾	5½	H

ABBREVIATIONS——ADE—Anderson Diesel Engine Co, Bud—Buda, Buc—Buckeye, Blk—Blackstone, Cat—Caterpillar, Ent—Enterprise Engine Co, FM—Fairbanks, Morse, GM—General Motors, Jaen—Jaehne (F Bauer & Co), Lis—Lister, Mod—Modaag, PMC—Power Mfg Co, Reid—Jos Reid Gas Engine Co, Rus—Ruston, Send—Sendling (F Bauer & Co), Str—Stover Mfg & Engine Co, Sup—Superior (National Supply Co), VS—Venn-Severin, Wauk—Waukesha.

Under starting method, A is air, E is electric, G is gasoline, H is hand.

* Moderate-pressure oil engine. ‡ Hesselman engine.
† 2-cycle engines, others are 4-cycle.

Typical Gas Engines

81 Plants Installed or Under Construction Since April 1, 1938

POWER, *June, 1939*—Page (335) 77.

Owner	Location	Equipt. Driven	Engine builder	No. engines	Horsepower	Speed, rpm	No. cyl	Cyl bore	Cyl stroke	Vertical or horizontal	Cycle	Btu per bhp-hr	Type of fue	Btu per cu ft of fuel
New York City	Tallmans Island, N.Y.(SP)	Blower	Wor	2	920	300	8	16	20	V	4	.....	Sew.	650
		Blower	Wor	2	460	328	4	16	20					
		Pump	Wor	2	360	400	6	12¼	14½	V	4	.....	Sew.	650
		Pump	Wor	2	180	400	3	12¼	14½					
Columbus	Ohio (SP)	Generator	RJ	3	750	300	7	15½	22	V	4	9,600	Sew.	650
Louisiana Ice & Elect Co	Alexandria, La.	Ind. Gen.	Wor	6*	750	225	6	18	25	V	4	.....	Nat.	† 1156
Phillips Petroleum Co	Borger, Tex.	Pump	CB	2	730	138	....	24	36	H	..	.....	.....	....
Gulf Oil Corp	Pittsburgh, Pa.	Ind. Gen.	RJ	2	600	300	5	15½	22	V	4	8,600	Nat.	1040
		Pumps	RJ	3	600	300	5	15½	22	V	4	8,600	Nat.	1040
Claremore	Oklahoma	Mun. Gen.	FIW	1	500	225	4	18	24½	..	4	9,500	Nat.	....
Atlanta Cotton Oil Co	Atlanta, Ga.	Line Shaft	BM	1	450	240	4	18½	20	V	4	10,000	Nat.	1000
Pennzoil Co	Oil City, Pa.	Oil Pump	Wor	1	375	400	6	12¼	14½	V	4	.....	Ref.	....
Detroit	Michigan (SP)	Mun. Gen.	Wor	1	364	400	6	12¼	14½	V	4	.....	Sew.	....
Arcadia Cotton Oil & Mfg. Co	Arcadia, La.	Ind. Gen.	BM	1	350	277	4	16½	17	V	4	10,000	Nat.	1000
Athens Brick & Tile Co	Athens, Tex.	Line Shaft	LeR	1	340	900	12	6¾	7	V	4	10,000	Nat.	1000
Liberty	Texas	Mun. Gen.	CB	2	300	400	6	11½	13½	V	4	.....	Nat.	....
Sallisaw	Oklahoma	Mun. Gen.	FIW	1	300	277	4	15	18	....	4	9,500	Nat.	....
Ft. Dodge	Iowa (SP)	Generator	CB	1	275	327	6	10½	14	V	4	.....	Sew.	650
Maricopa Co. Water Consv. Dist	Phoenix, Ariz.	Pump	LeR	1	250	1000	8	6¾	7	V	4	10,000	Nat.	1000
Lansing	Michigan (SP)	Blower	Wor	1	240	392	4	12½	14½	V	4	.....	Sew.	....
Fred Harrison Gin Co	Jarrell, Texas	Cotton Gin	LeR	1	240	900	8	6¾	7	V	4	10,000	Nat.	1000
Howard & Jones Gin	Moody, Texas	Cotton Gin	LeR	1	240	900	8	6¾	7	V	4	10,000	Nat.	1000
L. E. Robinson Gin	O'Donnell, Texas	Cotton Gin	LeR	1	240	900	8	6¾	7	V	4	10,000	Nat.	1000
Producers Gin Co	Loraine, Texas	Cotton Gin	LeR	1	240	900	8	6¾	7	V	4	10,000	Nat.	1000
Los Nietos Valley Ice Co	Downey, Calif.	Ref. Comp.	Wauk	1	200	800	6	7	7	V	4	.....	Nat.	....
		Generator	Wauk	1	200	800	6	7	7	V	4	.....	Nat.	....
		Generator	Wauk	1	135	1000	6	5½	5½	V	4	.....	Nat.	....
Polar Wave Ice Co	Houston, Texas	Generator	BM	1	185	300	4	12¼	15	V	4	10,000	Nat.	1000
Electric Gin Co	Taylor, Texas	LeR	LeR	1	170	900	6	6¾	7	V	4	10,000	Nat.	1000
		.....		1	55	900	4	5	6	V	4	10,000	Nat.	1000
Hobbs Co-op. Gin	Rotan, Texas	Cotton Gin	LeR	1	170	900	6	6¾	7	V	4	10,000	But.	3200
Choctaw Cotton Oil Co	Durant, Okla.	Cotton Gin	LeR	1	170	900	6	6¾	7	V	4	10,000	Nat.	1000
W. C. High Gin Co	Thackerville, Okla.	Cotton Gin	LeR	1	170	900	6	6¾	7	V	4	10,000	But.	3200
Pecos Valley Gin Co	Barstow, Texas	Cotton Gin	LeR	1	170	900	6	6¾	7	V	4	10,000	Nat.	1000
Producers Co-op. Gin	Ennis, Texas	Cotton Gin	LeR	1	170	900	6	6¾	7	V	4	10,000	Nat.	1000
Home Water Co	Ontario, Calif.	Water Pump	Wauk	1	165	750	4	7½	8	V	4	.....	Nat.	....
San Gabriel Valley Water Service	ElMonte, Calif.	Water Pump	Wauk	1	165	750	4	7½	8	V	4	11,500	Nat.	....
San Gabriel Valley Water Service	N. ElMonte, Calif.	Water Pump	Wauk	1	165	750	4	7½	8	V	4	.....	But.	....
Oshkosh	Wisconsin (SP)	Generator	LeR	2	160	720	6	6¼	7	V	4	10,000	Sew.	600
Bradbury & Marchant	Albuquerque, N. Mex.	Ind. Gen.	Wor	1	150	514	5	9	10½	V	4	.....	Sew.	....

Below 150 hp per engine

Pacific Tile & Porcelain Co	La Habra, Calif.	Compressor	Wauk	1	135	1000	6	5½	5½	V	4	.....	Nat.	....
Calif. Mich. Land & Water Co	E. Pasadena, Calif.	Water Pump	Wauk	1	135	1000	6	5½	5½	V	4	.....	Nat.	....
Big Three Welding Equipt. Co	Tulsa, Okla.	Comp. & Gen.	BM	1	130	327	4	11	12	V	4	10,000	Nat.	1000
Hugo Zimmerman	Shafter, Calif.	Water Pump	Wauk	1	125	860	4	6½	7	V	4	.....	Nat.	....
Maywood Mutual Water Co	Huntington Park, Calif.	Water Pump	Wauk	1	125	860	4	6½	7	V	4	.....	But.	....
F. A. Stearns	Corona, Calif.	Water Pump	Wauk	1	125	860	4	6½	7	V	4	.....	Nat.	....
San Gabriel Valley Water Service	Indio, Calif.	Water Pump	Wauk	1	125	860	4	6½	7	V	4	.....	But.	....
Caddo-De Soto Cotton Oil Co	Shreveport, La.	Comp. & Gen.	BM	1	115	514	4	8¾	10½	V	4	10,000	Nat.	1000
National Petroleum Co	Titusville, Penn.	Ind. Gen.	NTP	1	108	600	8	6	9	V	4	10,000	Nat.	250‡
So. Calif. Gas Co	Los Angeles, Calif.	Ref. Comp.	Wauk	1	90	1160	6	4⅝	5⅛	V	4	.....	Nat.	....
Findlay	Ohio	Blower	Wor	1	90	720	6	6½	7½	V	4	.....	Sew.	....
Chicago Foundry Co	Chicago, Ill.	Air Comp.	Wauk	1	87.5	1050	4	6	6½	V	4	11,000	City	800
R. H. Sides	Moreno, Calif.	Water Pump	Wauk	1	85	900	4	6	6½	V	4	.....	Nat.	....
Zelienople	Pennsylvania	Water Pump	NTP	1	80	600	6	6	9	V	4	10,000	Nat.	1000
Carnation Milk Co	Neosha, Mo.	Ind. Gen.	Wauk	1	75	1600	6	4¼	4¾	V	4	11,200	Nat.	1000
Atlanta Gas Light Co	Atlanta, Ga.	Air Comp.	Wauk	1	75	1600	6	4¼	4¾	V	4	11,200	Nat.	1000
Mandan Creamery Products Co	Mandan, N. Dak.	Ref. Comp.	Wauk	1	70	2000	6	3¾	4¼	V	4	11,200	Nat.	1000
		Ref. Comp.	Wauk	1	30	1800	4	3¼	4	V	4	10,800	Nat.	1000
Nozzle Water Co	Laverne, Calif.	Water Pump	Wauk	1	70	2000	6	3¾	4¼	V	4	.....	Nat.	....
			Wauk	1	65	900	4	5⅛	6¼	V	..	.....	Nat.	....
Gas Service Co	Kansas City, Kan.	Ref. Comp.	Wauk	1	70	2000	6	3¾	4¼	V	4	11,200	Nat.	1000
			Wauk	1	30	1800	4	3¼	4	V	4	10,800	Nat.	1000
Independent Ice & Ref. Co	Seminole, Okla.	Compressor	BM	1	70	360	2	11	12	V	4	10,000	Nat.	1000
		Generator	BM	1	40	400	2	8½	9	V	4	10,000	Nat.	1000
Valencia Water Co	Los Angeles Co., Calif.	Pump	Ent	1	66	615	4	7	8½	V	4	10,000	Nat.	1000
H. D. West	Shafter, Calif.	Water Pump	Wauk	1	65	900	4	5⅛	6¼	V	4	11,000	Nat.	1100
Felicina Sassia	Tehachopi, Calif.	Water Pump	Wauk	1	65	900	4	5⅛	6¼	V	4	.....	Nat.	....
Mascart Water Co	Redlands, Calif.	Water Pump	Wauk	1	65	900	4	5⅛	6¼	V	4	.....	Nat.	....
Ward Ice Co	Fayetteville, Ark.	Compressor	NTP	1	65	720	4	6	9	V	4	10,000	Nat.	1000
		Compressor	NTP	1	55	600	4	6	9	V	4	10,000	Nat.	1000
General Petroleum Corp	Long Beach, Calif.	Pump	Ent	1	64	720	4	7	8½	V	4	10,000	Nat.	1000
Shadyside Water Works	Shadyside, Ohio	Pump	BM	1	55	300	2	10	12	V	4	10,000	Nat.	1000
Ward Ice Cream Co	Fort Smith, Ark.	Compressor	NTP	1	55	600	4	6	9	V	4	10,000	Nat.	1000
Battle Creek	Michigan (SP)	Pump	LeR	1	50	....	4	5	7	V	4	10,000	Sew.	600
Refrigeration Service Co	Denver, Colo.	Ref. Comp.	Wauk	1	50	1400	4	4½	5¼	V	4	11,200	Nat.	900
No. Central Gas Co	Casper, Wyo.	.....	Wauk	1	50	1400	4	4½	5¼	V	4	11,200	Nat.	900
		.....	Wauk	1	37.5	1800	4	3⅝	4½	V	4	11,000	Nat.	900
D. J. Classen	Bakersfield, Calif.	Water Pump	Wauk	1	50	1050	4	4½	5¼	V	4	.....	Nat.	....
Newcastle	Indiana (SP)	Blower	Wor	1	45	720	3	6½	7½	V	4	.....	Sew	....
Crawfordsville	Indiana (SP)	Blower	LeR	1	44	600	4	5	7	V	4	10,000	Sew.	600
Mich. Fuel & Light Co	Battle Creek, Mich.	Pump	Wauk	1	30	1800	4	3¼	4	V	4	10,800	Nat.	1000
Eastern Shore Gas Co	Pocomoke, Md.	Ref. Comp.	Wauk	1	30	1800	4	3¼	4	V	4	10,800	Nat.	1000
Culinarts Products Co	Chicago, Ill.	Ref. Comp.	Wauk	1	30	1800	4	3¼	4	V	4	10,800	City	1000
LaPorte	Indiana (SP)	Mun. Gen.	LeR	1	27	720	4	4	5	V	4	10,000	Sew.	600
M., St. P. & St. Ste. M. Ry	Minneapolis, Minn.	Ref. Comp.	Wauk	6	25	1600	4	3¼	4	V	4	.....	Prop.	....
C. N. N. Ry	Chicago, Ill.	Ref. Comp.	Wauk	25	25	1600	4	3¼	4	V	4	.....	Prop.	....
		Generator	Wauk	20	25	1600	4	3¼	4	V	4	.....	Prop.	....
C M. & St. P. & P. Ry	Chicago, Ill.	Ref. Comp.	Wauk	12	25	1600	4	3¼	4	V	4	.....	Prop.	....
C. R. I & P. Ry	Chicago, Ill.	Generator	Wauk	17	25	1600	4	3¼	4	V	4	.....	Prop.	....
		Ref. Comp.	Wauk	16	25	1600	4	3¼	4	V	4	.....	Prop.	....
North Pacific Ry	N. Paul, Minn.	Ref. Comp.	Wauk	14	25	1600	4	3¼	4	V	4	.....	Prop.	....
Union Pacific Ry	Omaha, Neb.	Ref. Comp.	Wauk	7	25	1600	4	3¼	4	V	4	.....	Prop.	....

ABBREVIATIONS——BM—Bruce-McBeth, CB—Cooper-Bessemer, Ent—Enterprise, FIW—Fulton Iron Works, LeR—LeRoi, NTP—National Transit Pump, RJ—Rathbun-Jones, Wauk—Waukesha, Wor—Worthington.
Under type of fuel: But.—butane, City—city gas, Nat.—natural gas, Prop.—propane, Ref.—refinery gas, Sew.—sewage gas.

(SP) following location denotes a sewage plant.
All installations are single-engine units, no tandem or twin installations reported.
* Each pair of engines drives a single 1250-kva. generator. † Convertible to oil.
‡ Mixture of gas and air from repressured wells.

Diesel Manufacturers and Suppliers

ALLIS-CHALMERS MFG CO
Milwaukee, Wis.

4-cycle vertical
4 cyl, 70 hp @ 1050 rpm, 5¼ x 6½
4 cyl, 85 hp @ 1050 rpm, 5¾ x 6½
6 cyl, 110 hp @ 1050 rpm, 5¼ x 6½

AMERICAN DIESEL ENGINE CO
Oakland, Calif. (1937 data)

4-cycle vertical
2 cyl, 35 hp @ 1200 rpm, 5½ x 7
4 cyl, 75 hp @ 1200 rpm, 5½ x 7
6 cyl, 125 hp @ 1200 rpm, 5½ x 7

AMERICAN LOCOMOTIVE CO
Diesel Engine Div,
30 Church St, New York, N.Y.

2-cycle vertical
4 cyl, 720 hp @ 277 rpm, 14 x 23½
5 cyl, 900 hp @ 277 rpm, 14 x 23½
6 cyl, 1080 hp @ 277 rpm, 14 x 23½
8 cyl, 1440 hp @ 277 rpm, 14 x 23½

4-cycle vertical
6 cyl, 540 hp @ 600 rpm, 12½ x 13
8 cyl, 720 hp @ 600 rpm, 12½ x 13
5 cyl, 730 hp @ 257 rpm, 17½ x 25
6 cyl, 875 hp @ 257 rpm, 17½ x 25
8 cyl, 1170 hp @ 257 rpm, 17½ x 25

AMERICAN M.A.N. CORP
40 Rector St, New York, N.Y. (1937 data)

2-cycle vertical
4-10 cyl, 412–1065 hp @ 375–400 rpm, 11 13/16 x 16½
4-10 cyl, 1310–3600 hp @ 220–250 rpm, 20½ x 27½

2-cycle, double-acting, vertical
3–10 cyl, 2250 –7650 hp @ 167 rpm, 23 5/8 x 35½
3– 9 cyl, 3000 –9000 hp @ 115 rpm, 27½ x 47¼
6– 9 cyl, 9600–14400 hp @ 105 rpm, 39 x 55

4-cycle vertical
3– 6 cyl, 42–85 hp @ 1200 rpm, 4¾ x 7⅛
3 & 6 cyl, 55 & 110 hp @ 1000 rpm, 5 1/16 x 7⅛
3– 8 cyl, 80–265 hp @ 1000 rpm, 6⅛ x 8 1/16
3– 8 cyl, 115 –310 hp @ 500 rpm, 8 1/16 x 13
5– 8 cyl, 215 –350 hp @ 650 rpm, 8 1/16 x 11 13/16
3– 8 cyl, 190 –510 hp @ 375 rpm, 11¼ x 16½
5–10 cyl, 490 –980 hp @ 600 rpm, 11 13/16 x 15
5– 8 cyl, 635–1015 hp @ 350 rpm, 14 3/16 x 21 5/16
6– 8 cyl, 995–1330 hp @ 250 rpm, 17¾ x 26
6– 8 cyl, 1280–1710 hp @ 215 rpm, 20 7/16 x 29⅛
6– 8 cyl, 1740–2320 hp @ 187 rpm, 24 x 33

ANDERSON DIESEL ENGINE CO
6245 State Rd, Tacony,
Philadelphia, Pa.

2-cycle vertical
1–6 cyl, 30–330 hp @ 250–277 rpm
1–6 cyl, 30–360 hp @ 277–327 rpm
1–6 cyl, 50–420 hp @ 257–360 rpm

ATLAS IMPERIAL DIESEL ENGINE CO
1000 19th Ave, Oakland, Calif.

4-cycle vertical
2 & 4 cyl, 18 & 40 hp @ 1000 rpm, 4¾ x 6½
3 cyl, 50 hp @ 720 rpm, 6¼ x 8
4 & 6 cyl, 70 & 100 hp @ 720 rpm, 6¼ x 8
2 & 3 cyl, 35 & 50 hp @ 650 rpm, 6½ x 8½
4 & 6 cyl, 70 & 105 hp @ 650 rpm, 6½ x 8½
3 cyl, 60 hp @ 450 rpm, 7½ x 10½
4 & 6 cyl, 80 & 120 hp @ 450 rpm, 7½ x 10½
3 & 4 cyl, 65 & 90 hp @ 450 rpm, 8 x 10½
3 cyl, 90 hp @ 400 rpm, 9 x 12
4 & 6 cyl, 120 & 180 hp @ 400 rpm, 9 x 12
3 cyl, 105 hp @ 360 rpm, 10 x 13
4 & 6 cyl, 140 & 210 hp @ 360 rpm, 10 x 13
3 & 4 cyl, 120 & 160 hp @ 360 rpm, 10½ x 13
3 cyl, 150 hp @ 327 rpm, 11½ x 15
4 & 6 cyl, 200 & 300 hp @ 327 rpm, 11½ x 15
3 cyl, 200 hp @ 327 rpm, 13 x 16
4 & 6 cyl, 265 & 400 hp @ 327 rpm, 13 x 16
6 cyl, 525 hp @ 300 rpm, 14½ x 18
6 cyl, 600 hp @ 300 rpm, 15 x 19
4 & 6 cyl, 80 & 120 hp @ 650 rpm, 7 x 8½
4 & 5 cyl, 135 & 165 hp @ 514 rpm, 9 x 10½
6 & 8 cyl, 200 & 275 hp @ 514 rpm, 9 x 10½

ATLAS-THORNBURG, DIESEL ENGINES, INC
Division of Atlas-Imperial,
Mattoon, Ill.

4-cycle vertical
1–4 cyl, 5–20 hp 1800 rpm, 3⅛ x 3¾

BALL-MUNCIE ENGINE CO
Muncie, Ind.

2-cycle vertical
1–4 cyl, 55–220 hp @ 327 rpm, 13 x 16
6 cyl, 330 hp @ 327 rpm, 13 x 16
1–4 cyl, 65–265 hp @ 277 rpm, 14¼ x 18
6 cyl, 400 hp @ 277 rpm, 14¼ x 18
also 2-cycle horizontal engines

BOLINDERS COMPANY, INC
33 Rector St, New York, N.Y.

2-cycle vertical
1–2 cyl, 10–20 hp @ 900–1000 rpm, 4¾ x 4¾
1 cyl, 25 hp @ 800– 900 rpm, 7⅛ x 7⅛
2 cyl, 50 hp @ 800– 900 rpm, 7⅛ x 7⅛
4 cyl, 100 hp @ 800– 900 rpm, 7⅛ x 7⅛
2 cyl, 70 hp @ 450 rpm, 10⅝ x 11
2 cyl, 90 hp @ 425 rpm, 11¾ x 12 1/16

Atlas Polar engines
2–7 cyl, 100–375 hp @ 600 rpm
3–8 cyl, 310–840 hp @ 429 rpm
3–8 cyl, 575–1540 hp @ 300 rpm

BROMFIELD MFG CO, INC
211 Northern Ave, Boston, Mass. (1937 data)

2-cycle vertical
1 cyl, 12 hp @ 750 rpm, 4 1/16 x 6¾
2 cyl, 25 hp @ 750 rpm, 4 1/16 x 6¾
2 cyl, 50 hp @ 500 rpm, 6¾ x 9⅞
Also 4-cycle vertical and horizontal

THE BUCKEYE MACHINE CO
Lima, Ohio

4-cycle vertical
2–5 cyl, 40–100 hp @ 514 rpm, 7⅛ x 10½
2–8 cyl, 75–300 hp @ 400 rpm, 9½ x 14
4–8 cyl, 300–675 hp @ 400 rpm, 13½ x 15½

THE BUDA COMPANY
Harvey, Illinois

4-cycle vertical
4 cyl, 37 hp @ 1700 rpm, 3⅝ x 4½
4 cyl, 47 hp @ 1800 rpm, 3⅝ x 4¾
6 cyl, 66 hp @ 1800 rpm, 3½ x 4¾
6 cyl, 90 hp @ 1600 rpm, 4 x 5½
6 cyl, 100 hp @ 1600 rpm, 4¼ x 5½
6 cyl, 123 hp @ 1300 rpm, 4¾ x 6½
6 cyl, 155 hp @ 1200 rpm, 5¼ x 7
6 cyl, 204 hp @ 1000 rpm, 6¼ x 8¾
6 cyl, 220 hp @ 1000 rpm, 6½ x 8¾

BUSCH-SULZER BROS DIESEL ENGINE CO
2nd & Utah Sts, St. Louis, Mo.

2-cycle vertical
5– 8 cyl, 875–1400 hp @ 300 rpm, 15½ x 21
4–12 cyl, 1300–4000 hp @ 240 rpm, 20½ x 27½

4-cycle vertical
3–8 cyl, 225– 665 hp @ 360–400 rpm, 13 x 17
3–8 cyl, 225– 665 hp @ 300–327 rpm, 13 x 20
4–8 cyl, 500–1100 hp @ 300–327 rpm, 16½ x 21
4–8 cyl, 500–1200 hp @ 257–327 rpm, 16½ x 24½
Other units up to 10,000 hp

CATERPILLAR TRACTOR CO
Peoria, Ill.

4-cycle vertical
V-8 cyl, 120–160 hp @ 850 rpm, 5¾ x 8
4 cyl, 24– 32 hp @ 1525 rpm, 3¾ x 5
4 & 6 cyl, 33 & 66 hp @ 1400 rpm, 4¼ x 5½
4 & 6 cyl, 50 & 100 hp @ 850 rpm, 5¼ x 8
3 & 4 cyl, 45 & 80 hp @ 850 rpm, 5¾ x 8
6 cyl, 95–125 hp @ 850 rpm, 5¾ x 8

CHICAGO PNEUMATIC TOOL CO
6 East 44th St, New York, N.Y.

4-cycle vertical
3–8 cyl, 90– 300 hp @ 514–720 rpm, 8 x 10½
3–8 cyl, 150– 400 hp @ 300–450 rpm, 10¾ x 14¼
3–8 cyl, 300– 800 hp @ 257–327 rpm, 14 x 22
3–8 cyl, 375–1000 hp @ 257–360 rpm, 16 x 20

CLARK BROS COMPANY
Olean, N.Y.

2-cycle horizontal
single and twin cyl, 55–165 hp
also gas engines convertible to diesel

CONSOLIDATED SHIPBUILDING CORP
Morris Heights, New York, N.Y.

4-cycle vertical marine engines

COOPER-BESSEMER CORP
Mt. Vernon, Ohio.

4-cycle vertical
3 & 4 cyl, 85– 110 hp @ 500 rpm, 8 x 10½
6 & 8 cyl, 160– 215 hp @ 500 rpm, 8 x 10½
6 & 8 cyl, 300– 400 hp @ 900 rpm, 8 x 10½
3 & 4 cyl, 105– 135 hp @ 450 rpm, 9 x 12
6 & 8 cyl, 210– 275 hp @ 450 rpm, 9 x 12
6 & 8 cyl, 300– 400 hp @ 650 rpm, 9 x 12
3 & 4 cyl, 160– 215 hp @ 450 rpm, 10½ x 13½
6 & 8 cyl, 320– 430 hp @ 450 rpm, 10½ x 13½
6 & 8 cyl, 550– 750 hp @ 750 rpm, 10½ x 13½
6 & 8 cyl, 460– 620 hp @ 450 rpm, 12 x 15
6–8 cyl, 750–1000 hp @ 300 rpm, 15½ x 22

CUMMINS ENGINE CO
Columbus, Ind.

4-cycle vertical
4 & 6 cyl, 13– 74 hp @ 600–2200 rpm, 4 x 5
4 & 6 cyl, 26–115 hp @ 600–1800 rpm, 4⅞ x 6
4 & 6 cyl, 63–184 hp @ 514–1000 rpm, 6¾ x 9
4 & 6 cyl, 67–196 hp @ 514–1000 rpm, 7 x 9
3–4 cyl, 57–118 hp @ 514– 800 rpm, 7 x 10
6 cyl, 114–222 hp @ 514–1000 rpm, 7 x 10

4-cycle Vee-type
12 cyl, 228–443 hp @ 514–1000 rpm, 7 x 10

DE LA VERGNE ENGINE CO
Paschall P. O., Philadelphia, Pa.

4-cycle vertical
6–8 cyl, 150– 240 hp @ 900–1200 rpm, 7 x 8
4–8 cyl, 135– 400 hp @ 450– 720 rpm, 9 x 12
3–8 cyl, 200– 800 hp @ 360– 600 rpm, 12½ x 15½
4–8 cyl, 350– 760 hp @ 300– 327 rpm, 15 x 18½
4–8 cyl, 460–1150 hp @ 300– 400 rpm, 16 x 20
4–8 cyl, 500–1000 hp @ 240 rpm, 17½ x 24
4–8 cyl, 800–1600 hp @ 200 rpm, 22 x 30

DIESEL DYNAMICS CORP
Woolworth Bldg, New York, N.Y. Deutz agents
2- and 4-cycle vertical and horizontal

ELECTRIC BOAT CO
Groton, Conn.

4-cycle vertical marine engines

ENTERPRISE ENGINE CORP
18th & Alabama Sts, San Francisco, Calif.

4-cycle vertical (1937 data)
3–8 cyl, 40–200 hp @ 500 rpm, 8 x 10
4–6 cyl, 100–250 hp @ 350 rpm, 10 x 13
6–8 cyl, 250–450 hp @ 400 rpm, 11½ x 14
6–8 cyl, 250–500 hp @ 360 rpm, 12 x 15
6–8 cyl, 500–900 hp @ 300 rpm, 16 x 20

F A B MANUFACTURING CO
67th & Vallejo Sts, Oakland, Calif

2-cycle vertical (1937 data)
1 cyl, 10 hp @ 700 rpm, 5¾ x 6
1 cyl, 15 hp @ 650 rpm, 6¾ x 7¼
1–2 cyl, 25–50 hp @ 550 rpm, 8 x 9¼
1–2 cyl, 30–60 hp @ 500 rpm, 9 x 10
1–2 cyl, 40–80 hp @ 450 rpm, 10¼ x 11

FAIRBANKS, MORSE & CO
600 S. Michigan Ave, Chicago, Ill.

2-cycle vertical
2– 6 cyl, 60– 180 hp @ 450 rpm, 8¾ x 10½
4– 6 cyl, 160– 240 hp @ 400 rpm, 10 x 12½
1– 3 cyl, 60– 180 hp @ 360 rpm, 12 x 15
1– 6 cyl, 75– 450 hp @ 300 rpm, 14 x 17
5– 7 cyl, 250– 360 hp @ 360 rpm, 10½ x 12½
5– 7 cyl, 500– 700 hp @ 400 rpm, 12 x 15
5– 7 cyl, 575– 805 hp @ 300 rpm, 14 x 17
4–10 cyl, 700–1750 hp @ 300 rpm, 16 x 20

4-cycle vertical
1–6 cyl, 10– 60 hp @ 1200 rpm, 4¼ x 6
4–8 cyl, 60–120 hp @ 900 rpm, 5½ x 7½
6–8 cyl, 225–300 hp @ 720 rpm, 8 x 10½

FRANK BAUER & CO
51 N Dean St, Englewood, N. J.

4-cycle horizontal
1 cyl, 14–15 hp @ 1250–1450 rpm, 5.5 x 7.8
1 cyl, 10–12 hp @ 975–1150 rpm, 4.6 x 6.5
1 cyl, 7– 8 hp @ 925–1075 rpm, 4.0 x 6.5
1 cyl, 5– 6 hp @ 750– 800 rpm, 3.4 x 4.8
1 cyl, 7– 9 hp @ 1100–1300 rpm, 4.2 x 6.6
1 cyl, 10–12 hp @ 1000–1100 rpm, 4.6 x 6.6
1 cyl, 14–16 hp @ 900–1100 rpm, 5.6 x 7.9
Sendling and Jaehne engines

FRANKLIN VALVELESS ENGINE CO
Franklin, Pa. (1937 data)

2-cycle horizontal
1 cyl, 25 hp @ 260 rpm, 11¼ x 12
1 cyl, 30 hp @ 260 rpm, 12 x 12
1 cyl, 35 hp @ 240 rpm, 13 x 13
1 cyl, 40 hp @ 240 rpm, 12 x 16
1 cyl, 50 hp @ 240 rpm, 14 x 15
1 cyl, 65 hp @ 260 rpm, 15 x 15

FULTON IRON WORKS
6400 Gambleton Pl, St. Louis, Mo.

4-cycle engine, V, up to 1800 hp

DIESEL ENGINE DIV, GENERAL MOTORS SALES CORP
Cleveland, Ohio.

2-cycle vertical
1 cyl, 15– 25 hp @ 1200–2000 rpm, 4¼ x 5
3 cyl, 45– 83 hp @ 1200–2000 rpm, 4¼ x 5
4 cyl, 60–110 hp @ 1200–2000 rpm, 4¼ x 5
6 cyl, 90–165 hp @ 1200–2000 rpm, 4¼ x 5
Also engines to 1200 hp.

HERCULES MOTORS CORP
Canton, Ohio.

4-cycle vertical
4 cyl, 14 .5– 62 hp @ 600–2600 rpm, 3¾ x 4½
4 cyl, 17 – 70 hp @ 600–2600 rpm, 4 x 4½
4 cyl, 19 – 56 hp @ 600–1600 rpm, 4¼ x 4½
6 cyl, 17 .5– 77 hp @ 600–2600 rpm, 3½ x 4½
6 cyl, 21 –83 hp @ 600–2600 rpm, 3¾ x 4½
6 cyl, 35 –120 hp @ 600–2000 rpm, 4⅜ x 5¼
6 cyl, 38 –103 hp @ 600–1400 rpm, 4⅝ x 5¼
6 cyl, 54 –160 hp @ 600–1600 rpm, 5 x 6
6 cyl, 74 –127 hp @ 600–1000 rpm, 5½ x 6

HILL DIESEL ENGINE CO
Lansing, Mich.

4-cycle vertical
2 cyl, 15 hp @ 1200 rpm, 3½ x 5½
1–4 cyl, 11–45 hp @ 720 rpm, 5 x 7
6 cyl, 65 hp @ 720 rpm, 5 x 7
4 & 6 cyl, 30 & 45 hp @ 1200 rpm, 3½ x 6
4 & 6 cyl, 74 & 112 hp @ 720 rpm, 6 x 10

F VAN ROSSEN HOOGENDYK
Graybar Bldg, New York, N. Y.
Representing MWM, Mercedes-Benz and Kromhout

HOOVEN, OWENS, RENTSCHLER DIV
General Machinery Corp, Hamilton, Ohio.

2-cycle vertical
1200–12,000 hp @ 120–250 rpm
Also marine engines (M A N license)

INGERSOLL-RAND CO
11 Broadway, New York, N. Y.

4-cycle vertical
3–8 cyl, 175–460 hp @ 600 rpm

INTERNATIONAL HARVESTER CO
180 N Michigan Ave, Chicago, Ill.
4-cycle vertical
4 cyl, 62.5 hp @ 1250 rpm, 4¾ x 6½
6 cyl, 100 hp @ 1400 rpm, 4¾ x 6½

JOHNSON MANUFACTURING CO
Fox and Holly Sts, Seattle, Wash
2-cycle vertical
1–6 cyl, 25–200 hp @ 350–600 rpm
4-cycle vertical
1–6 cyl, 17–105 hp @ 500 rpm, 7¼ x 8

KAHLENBERG BROS CO
Two Rivers, Wis.
2-cycle vertical
1–4 cyl, 15– 70 hp @ 400–425 rpm
1–6 cyl, 25–180 hp @ 360–400 rpm
2 cyl, 20– 24 hp @ 450–480 rpm
3 cyl, 135–150 hp @ 277–327 rpm
4–6 cyl, 200–300 hp @ 327 rpm

MARKEY MACHINERY CO, INC
85 Horton St, Seattle, Wash.
2-cycle vertical (1937 data)
12–32 hp, 425–450 rpm

MURPHY DIESEL CO, LTD
5317 W Burnham St, Milwaukee, Wis.
4-cycle vertical
4 cyl, 83–104 hp @ 200–1200 rpm, 5¾ x 6½
6 cyl, 128–160 hp @ 200–1200 rpm, 5¾ x 6½
6 cyl, 160–200 hp @ 200–1200 rpm, 5¾ x 6½

NATIONAL SUPPLY CO
Superior Engine Div,
Holmesburg, Philadelphia, Pa.,
and Springfield, Ohio.
4-cycle vertical
2 cyl, 28 hp @ 1400 rpm, 4½ x 5¾
4 cyl, 62 hp @ 1500 rpm, 4½ x 5¾
6 cyl, 100 hp @ 1600 rpm, 4½ x 5¾
8 cyl, 150 hp @ 1800 rpm, 4½ x 5¾
6 & 8 cyl, 170 & 230 hp @ 1500 rpm, 5½ x 7
3–8 cyl, 50–180 hp @ 514–720 rpm, 7 x 9
3–8 cyl, 90–350 hp @ 400–600 rpm, 9 x 12
4–6 cyl, 200–425 hp @ 360–514 rpm, 11½ x 14
3–8 cyl, 160–560 hp @ 300–400 rpm, 12½ x 15
3–8 cyl, 175–615 hp @ 300–400 rpm, 12½ x 16½
4–8 cyl, 315–810 hp @ 277–360 rpm, 14½ x 18
4–8 cyl, 350–900 hp @ 277–360 rpm, 14½ x 20

NORDBERG MFG CO
Milwaukee, Wis.
2-cycle vertical
3–8 cyl, 750–2000 hp @ 257 rpm, 17 x 25
4–8 cyl, 1500–3000 hp @ 225 rpm, 21 x 29
4-cycle vertical
5 cyl, 625 hp @ 325 rpm, 16 x 20
6 cyl, 750 hp @ 325 rpm, 16 x 20
8 cyl, 1000 hp @ 325 rpm, 16 x 20

NORTHILL COMPANY, INC
6824 McKinley Rd, Los Angeles, Calif.
4-cycle, vertical opposed cylinder
1 cyl, 15–18 hp, $3\frac{5}{32}$ x $3\frac{5}{16}$
also other engines, Covic license

PAGE ENGINEERING CO
Clearing P. O., Chicago, Ill.
4-cycle dragline diesels

PEET & POWERS, INC
70 East 45th St, New York, N. Y.
Lister, Ruston & Blackstone engines
4-cycle vertical
1 cyl, 3.5 hp @ 650 rpm, 3¾ x 5½
1–2 cyl, 8–16 hp @ 1200 rpm, 4⅜ x 5½
1–4 cyl, 3–40 hp @ 1200 rpm, 4½ x 5½
1–2 cyl, 3–10 hp @ 650 rpm, 4½ x 5½
1–8 cyl, 60–1200 hp @ 900–400 rpm, 5–14 x 8–20
4-cycle horizontal
1–4 cyl, 7–260 hp @ 290 rpm, 5–13 x 9–22
1 cyl, 22 hp @ 600 rpm, 7¼ x 9½
1 cyl 37 hp @ 500 rpm, 8¾ x 13
1 cyl, 50 hp @ 450 rpm, 10 x 14

PIONEER EQUIPMENT CORP OF AMERICA
Woolworth Bldg, New York, N. Y.
Krupp and Schlueter engines
2- and 4-cycle, single- and double-acting engines

POWER MANUFACTURING CO
Marion, Ohio. (1937 data)
2-cycle engines
V & H, to 185 hp, 327 rpm

RED WING MOTOR CO
Red Wing, Minn. (1937 data)
4-cycle vertical
4 cyl, 35– 40 hp @ 1400 rpm, 3⅜ x 4¾
4 cyl, 55– 60 hp @ 1500 rpm, 4½ x 5
6 cyl, 65– 75 hp @ 1800 rpm, 3¾ x 4¼
4 cyl, 80– 90 hp @ 1050 rpm, 6 x 6½
6 cyl, 75–100 hp @ 1500 rpm, 4⅜ x 5½
6 cyl, 120–140 hp @ 1500 rpm, 5 x 5½
6 cyl, 160–180 hp @ 1050 rpm, 6½ x 7
6 cyl, 180–200 hp @ 1050 rpm, 7 x 7
Comet and Hesselman licenses

RATHBUN-JONES ENGINEERING CO
Toledo, Ohio.
4-cycle vertical
3–8 cyl, 187– 525 hp @ 400 rpm, 11 x 18
3–8 cyl, 260– 700 hp @ 300 rpm, 13¼ x 22
3–8 cyl, 375–1025 hp @ 277 rpm, 16 x 24
5–8 cyl, 960–1500 hp @ 240 rpm, 19½ x 28

JOSEPH REID GAS ENGINE CO
Box 177, Oil City, Pa.
2-cycle horizontal
1 cyl, 11– 24 hp @ 250–550 rpm, 7½ x 9
1–2 cyl, 23– 80 hp @ 250–500 rpm, 9 x 12
2 cyl, 59–103 hp @ 250–500 rpm, 10¼ x 12
1–2 cyl, 30–114 hp @ 200–425 rpm, 10¾ x 14
1–2 cyl, 33–124 hp @ 200–425 rpm, 11½ x 14
1–2 cyl, 40–162 hp @ 175–375 rpm, 12½ x 16
1–2 cyl, 42–172 hp @ 175–375 rpm, 13¼ x 16
1 cyl, 52– 92 hp @ 175–325 rpm, 13¼ x 18
2-cycle vertical
2 cyl, 23– 53 hp @ 250–600 rpm, 7½ x 9

STANDARD DIESEL ENGINE CO
150 Whiton St, Jersey City, N. J.
4-cycle vertical (1937 data)
1–8 cyl, 15–120 hp @ 600 rpm, 6 x 8
3–8 cyl, 75–200 hp @ 360 rpm, 8½ x 12
6 & 8 cyl, 220 & 295 hp @ 327 rpm, 10 x 14
6 & 8 cyl, 285 & 375 hp @ 327 rpm, 11 x 15
6 & 8 cyl, 375 & 500 hp @ 327 rpm, 12 x 17
6 & 8 cyl, 445 & 590 hp @ 300 rpm, 13½ x 17

STERLING ENGINE COMPANY
1250 Niagara St, Buffalo, N. Y.
2-cycle, opposed-piston engine
4 cy *, 135–150 hp @ 1200 rpm, 4.24 x 5.45
*8 pistons (Michell patents)

STOVER MFG & ENGINE CO
Freeport, Ill.
4-cycle vertical
1 cyl, 5 hp @ 900–1200 rpm, 3⅞ x 5¼
1 cyl, 7½ hp @ 900–1200 rpm, 4¼ x 5¼
1 cyl, 10 hp @ 1000–1200 rpm, 5 x 6½
1 cyl, 15 hp @ 1000–1200 rpm, 5½ x 6½

SUN SHIPBUILDING & DRYDOCK CO
Chester, Pa. Marine engines

TIPS ENGINE WORKS
Austin, Texas. (1937 data)
2-cycle horizontal
1 cyl, 40 hp, 12½ x 13
1 cyl, 25 hp, 10 x 12

THE TITUSVILLE IRON WORKS CO
Titusville, Pa.
2-cycle horizontal
1 cyl, 40 hp @ 120–350 rpm, 11 x 15
1 cyl, 50 hp @ 120–350 rpm, 12 x 15
1 cyl, 65 hp @ 120–350 rpm, 12½ x 16
1 cyl, 70 hp @ 120–350 rpm, 13¼ x 16
2 cyl, 150 hp @ 120–400 rpm, 13 x 18
2 cyl, 180 hp @ 120–400 rpm, 14 x 18
2 cyl, 210 hp @ 120–400 rpm, 16 x 18
2-cycle vertical
2 cyl, 50 hp @ 150–600 rpm, 7½ x 10
2 cyl, 60 hp @ 150–600 rpm, 8 x 10
2 cyl, 75 hp @ 150–600 rpm, 9 x 10

THE UNION DIESEL ENGINE CO
Kennedy & E 7th Sts, Oakland, Calif.
4-cycle vertical
3 & 4 cyl, 75 & 100 hp @ 450 rpm, 8 x 11
6 cyl, 150 hp @ 450 rpm, 8 x 11
3 & 4 cyl, 100 & 130 hp @ 400 rpm, 9 x 13
6 cyl, 200 hp @ 400 rpm, 9 x 13
4 & 6 cyl, 170 & 260 hp @ 400 rpm, 10 x 14
3 & 4 cyl, 135 & 185 hp @ 327 rpm, 11 x 15
6 cyl, 275 hp @ 327 rpm, 11 x 15
4 cyl, 250 hp @ 300 rpm, 12½ x 17
6 & 8 cyl, 375 & 500 hp @ 300 rpm, 12½ x 17
6 cyl, 480 hp @ 277 rpm, 14 x 19
6 & 8 cyl, 640 & 850 hp @ 257 rpm, 16 x 20½

UNION MACHINE CO
934 Brannan St, San Francisco, Calif.
2-cycle vertical (1937 data)
2–8 cyl, 65–270 hp @ 375 rpm, 9 x 12

VENN-SEVERIN MACHINE CO
1317 W North Ave, Chicago, Ill.
2-cycle vertical
1–2 cyl, 20– 40 hp @ 650 rpm, 7 x 8
1–2 cyl, 30– 60 hp @ 400 rpm, 10½ x 12
3–4 cyl, 100–125 hp @ 425 rpm, 10½ x 12
1–2 cyl, 40– 85 hp @ 300 rpm, 12¼ x 13½
2–4 cyl, 100–200 hp @ 327 rpm, 12¼ x 13½
1–4 cyl, 60–275 hp @ 300 rpm, 14¼ x 16½
2–4 cyl, 140–300 hp @ 327 rpm, 14¼ x 16½
Moderate-pressure oil engines

WASHINGTON IRON WORKS
1500 6th Ave, South, Seattle, Wash.
4-cycle vertical (1937 data)
2–6 cyl, 45–135 hp @ 450 rpm, 8½ x 10
3–6 cyl, 80–160 hp @ 400 rpm, 9 x 11½
3–6 cyl, 100–200 hp @ 360 rpm, 10 x 12½
3–8 cyl, 120–320 hp @ 360 rpm, 10¼ x 13½
3–8 cyl, 150–400 hp @ 327 rpm, 11½ x 15
4–8 cyl, 240–480 hp @ 300 rpm, 13 x 16
6 & 8 cyl, 450 & 600 hp @ 270 rpm, 14½ x 18
6 & 8 cyl, 600 & 800 hp @ 257 rpm, 16¼ x 20
6 & 8 cyl, 750 & 1000 hp @ 225 rpm, 18 x 24

WAUKESHA MOTOR CO
Waukesha, Wis.
4-cycle vertical
4 cyl, 37– 48 hp @ 1500–2200 rpm, 3¾ x 5
6 cyl, 65– 90 hp @ 1400–2500 rpm, 3¾ x 5
6 cyl, 60– 80 hp @ 1800–2600 rpm, 3⅜ x 4½
4 cyl, 42– 55 hp @ 1500–2200 rpm, 4 x 5
6 cyl, 75–100 hp @ 1400–2500 rpm, 4 x 5
6 cyl, 95–110 hp @ 1200–2200 rpm, 4¼ x 5½
6 cyl, 75–100 hp @ 1500–2200 rpm, 4⅜ x 5½
6 cyl, 105–125 hp @ 1200–2200 rpm, 4½ x 5½
4 cyl, 55– 59 hp @ 1400–1600 rpm, 4⅝ x 5¼
6 cyl, 125–150 hp @ 1200–1800 rpm, 4¾ x 6
6 cyl, 110–140 hp @ 1500–2000 rpm, 5 x 5½
4 cyl, 65– 72 hp @ 1050–1200 rpm, 5 x 6½
6 cyl, 135–160 hp @ 1200–1800 rpm, 5¼ x 6
6 cyl, 156–172 hp @ 1300–1600 rpm, 5¾ x 6½
4 cyl, 88– 96 hp @ 1050–1200 rpm, 6 x 6½
6 cyl, 185–202 hp @ 1300–1600 rpm, 6¼ x 6½
6 cyl, 166–171 hp @ 1050–1125 rpm, 6½ x 7
4 cyl, 112–116 hp @ 950–1050 rpm, 6½ x 8
6 cyl, 189–196 hp @ 1050–1125 rpm, 7 x 7
6 cyl, 214–226 hp @ 900–1050 rpm, 7 x 8½
6 cyl, 300–333 hp @ 900–1050 rpm, 8½ x 8½
Hesselman license

WEBER ENGINE COMPANY
12th & Winchester Sts, Kansas City, Mo.
2-cycle vertical
2 cyl, 50 hp @ 400 rpm, 7½ x 9
2 cyl, 40 hp @ 400 rpm, 7½ x 9
2-cycle horizontal
1 cyl, 25 hp @ 180 rpm, 10¼ x 14
1 cyl, 30 hp @ 180 rpm, 11 x 14
1 cyl, 35 hp @ 180 rpm, 12 x 14
1 cyl, 40 hp @ 180 rpm, 13 x 14
1 cyl, 50 hp @ 180 rpm, 14 x 14
all engines convertible to gas

WESTERN ENGINE CORP
1000 Alhambra Ave, Los Angeles, Calif. No data.

WITTE ENGINE WORKS
1600 Oakland Ave, Kansas City, Mo. No data.

WOLVERINE MOTOR WORKS, INC
Bridgeport, Conn.
2-cycle vertical
2–5 cyl, 25–90 hp @ 425–500 rpm, 6⅝ x 8⅝
4-cycle vertical
2–4 cyl, 50–120 hp @ 360–400 rpm, 8½ x 12½
2–6 cyl, 65–225 hp @ 360–400 rpm, 9¼ x 14
also marine engines

WORTHINGTON PUMP & MACHINERY CORP
Harrison, N. J.
4-cycle vertical
2– 6 cyl, 60–180 hp @ 600 rpm, 8 x 10½
3– 8 cyl, 170– 450 hp @ 450 rpm, 10¾ x 14½
3– 8 cyl, 250– 665 hp @ 360 rpm, 13¼ x 17½
3–12 cyl, 375–1500 hp @ 327 rpm, 16 x 20
3–12 cyl, 375–1500 hp @ 225 rpm, 17 x 25

Gas Engines

THE BRUCE MACBETH ENGINE CO
2111 Center St, NW, Cleveland, Ohio.
4-cycle vertical
3, 4, 6 cyl, 85–200 hp @ 514–600 rpm, 8¾ x 10½
2 cyl, 40– 45 hp @ 400–450 rpm, 8½ x 9
2 & 4 cyl, 55–120 hp @ 327–360 rpm, 10 x 12
2 & 4 cyl, 65–145 hp @ 327–360 rpm, 11 x 12
2 & 4 cyl, 80–185 hp @ 277–300 rpm, 12¼ x 15
2 & 4 cyl, 90–225 hp @ 277–300 rpm, 13½ x 15
4 cyl, 250–270 hp @ 257–277 rpm, 14½ x 17
4 cyl, 325–350 hp @ 257–277 rpm, 16½ x 17
4 cyl, 425–450 hp @ 225–240 rpm, 18½ x 20

CLARK BROS COMPANY
Olean, N. Y.
2-cycle vertical
2–3 cyl, 165–250 hp @ 300 rpm, 12½ x 14
4 & 6 cyl, 335–500 hp @ 300 rpm, 12½ x 14
2–6 cyl, 150–600 hp @ 300 rpm
2-cycle horizontal
60–250 hp, double and single-engine units
1–2 cyl, 220–440 hp Also other pumping units

CLIMAX ENGINEERING CO
Harms Trust Bldg, Chicago, Ill. No data

COOPER-BESSEMER CORP
Mt. Vernon, Ohio.
4-cycle vertical
6 & 8 cyl, 140–425 hp @ 400–900 rpm, 9 x 10½
3 & 4 cyl, 130–220 hp @ 350–450 rpm, 11½ x 13½
6 & 8 cyl, 260–750 hp @ 350–750 rpm, 11½ x 13½
5–8 cyl, 235–675 hp @ 250–450 rpm, 13 x 16
5–8 cyl, 365–880 hp @ 200–300 rpm, 15½ x 22

ENTERPRISE ENGINE CO
2902 19th St, San Francisco, Calif. No data

INGERSOLL-RAND CO
11 Broadway, New York, N. Y.
4-cycle vertical
3–8 cyl, 175–460 hp @ 600 rpm
4, 6, 8 cyl, 185, 275, 370 hp @ 400 rpm

LEROI COMPANY
1706 S 68th St, Milwaukee, Wis.
4-cycle vertical
2 & 4 cyl, 4– 16 hp @ 900–1800 rpm, 2¼ x 3½
2 cyl, 4½– 8½ hp @ 800–1500 rpm, 3⅛ x 4
2 & 4 cyl, 5½– 21 hp @ 800–1500 rpm, 3⅛ x 4½
4 cyl, 12– 25 hp @ 800–1800 rpm, 3¼ x 4
4 cyl, 14– 26 hp @ 800–1500 rpm, 3⅜ x 4½
4 cyl, 18– 39 hp @ 800–1800 rpm, 3¾ x 4
4 cyl, 20– 44 hp @ 800–1800 rpm, 4 x 4
4 cyl, 32– 52 hp @ 800–1400 rpm, 4½ x 5
4 cyl, 38– 57 hp @ 800–1200 rpm, 4½ x 6
4 cyl, 47– 69 hp @ 800–1200 rpm, 5 x 6
4 & 6 cyl, 43–104 hp @ 600–1200 rpm, 5 x 7
4 & 6 cyl, 53–138 hp @ 600–1200 rpm, 5½ x 7
4 & 6 cyl, 63–165 hp @ 600–1200 rpm, 6 x 7
4 & 6 cyl, 68–180 hp @ 600–1200 rpm, 6¼ x 7
4 & 6 cyl, 79–208 hp @ 600–1200 rpm, 6¾ x 7
8 & 12 cyl, 136–360 hp @ 600–1200 rpm, 6¼ x 7
8 & 12 cyl, 158–416 hp @ 600–1200 rpm, 6¾ x 7

NATIONAL TRANSIT PUMP & MACHINE CO
Oil City, Pa.
4-cycle horizontal single-acting
1–4 cyl, 85–325 hp @ 90–210 rpm, 17 x 24
4-cycle vertical single-acting
2–8 cyl, 20–128 hp @ 300–720 rpm, 6 x 9
4-cycle horizontal double-acting
2–4 cyl, 600–1200 hp @ 62½–125 rpm, 23 x 36

RATHBUN-JONES ENGINEERING CO
Toledo, Ohio.
4-cycle vertical
3–8 cyl, 235– 626 hp @ 360 rpm, 12¾ x 18
3–8 cyl, 355– 950 hp @ 300 rpm, 15½ x 22
3–8 cyl, 510–1360 hp @ 277 rpm, 18½ x 24
6–8 cyl, 1590–2120 hp @ 240 rpm, 23 x 28
6 cyl, 1200 hp @ 225 rpm, 22 x 26

STERLING ENGINE CO
1270 Niagara St, Buffalo, N. Y.
4-cycle vertical
6 cyl, 170 hp @ 1200 rpm, 5¾ x 6¾
8 cyl, 230 hp @ 1200 rpm, 5¾ x 6¾
6 cyl, 60–100 hp @ 1200 rpm, 5¼ x 6
6 cyl, 225–300 hp @ 900 rpm, 8 x 9
8 cyl, 325–400 hp @ 900 rpm, 8 x 9

JOSEPH REID GAS ENGINE CO
Box 177, Oil City, Pa.
2-cycle vertical
2 cyl, 26–55 hp @ 250–550 rpm, 7½ x 9
2 cyl, 30–65 hp @ 250–550 rpm, 8¼ x 9
2-cycle horizontal
1 cyl, 14– 30 hp @ 250–550 rpm, 7½ x 9
1 cyl, 16– 35 hp @ 250–550 rpm, 8¼ x 9
1–2 cyl, 27– 93 hp @ 250–500 rpm, 9 x 12
1–2 cyl, 34–126 hp @ 250–500 rpm, 10¼ x 12
1–2 cyl, 35–132 hp @ 200–425 rpm, 10¾ x 14
1–2 cyl, 40–147 hp @ 200–425 rpm, 11½ x 14
1 cyl, 44– 81 hp @ 200–425 rpm, 12¼ x 14
1–2 cyl, 50–188 hp @ 175–375 rpm, 12½ x 16
1–2 cyl, 52–204 hp @ 175–375 rpm, 13¼ x 16
1 cyl, 72–126 hp @ 175–325 rpm, 14½ x 18
1 cyl, 78–134 hp @ 175–325 rpm, 15 x 18

TITUSVILLE IRON WORKS CO
Titusville, Pa.
2-cycle horizontal
1 cyl, 40– 45 hp @ 120–300 rpm, 11 x 15
1 cyl, 45– 55 hp @ 120–350 rpm, 12 x 15
2 cyl, 125 hp @ 120–350 rpm, 12 x 15
1 cyl, 65 hp @ 120–350 rpm, 12½ x 16
1–2 cyl, 55–150 hp @ 120–400 rpm, 13 x 18
1–2 cyl, 60–180 hp @ 120–400 rpm, 14 x 18
1 cyl, 70 hp @ 120–350 rpm, 13¼ x 16
2 cyl, 210 hp @ 120–400 rpm, 16 x 18
2-cycle vertical
2 cyl, 50 hp @ 150–600 rpm, 7½ x 10
2 cyl, 60 hp @ 150–600 rpm, 8 x 10
2 cyl 75 hp @ 150–600 rpm, 9 x 10

WORTHINGTON PUMP & MACHINERY CORP
Harrison, N. J.
4-cycle vertical
3– 6 cyl, 30– 90 hp @ 720 rpm, 6½ x 7½
2– 6 cyl, 70– 210 hp @ 600 rpm, 9 x 10½
4– 8 cyl, 180– 360 hp @ 400 rpm, 11½ x 12
3– 8 cyl, 200– 535 hp @ 450 rpm, 12¾ x 14½
3– 8 cyl, 300– 800 hp @ 360 rpm, 15 x 17½
3–12 cyl, 345–1380 hp @ 360 rpm, 16 x 20
3–12 cyl, 450–1800 hp @ 225 rpm, 20 x 25

WAUKESHA MOTOR CO
Waukesha, Wis.
4-cycle vertical
4 cyl, 7 – 18 hp @ 1000–2600 rpm, 2½ x 3⅛
4 cyl, 12½– 25½ hp @ 1000–2600 rpm, 2¾ x 4
4 cyl, 17½– 35 hp @ 1000–2600 rpm, 3¼ x 4
6 cyl, 32 – 72 hp @ 1000–2800 rpm, 3½ x 4¼
6 cyl, 34 – 77 hp @ 1000–2800 rpm, 3⅝ x 4¼
4 cyl, 25 – 42½ hp @ 1000–2200 rpm, 3⅝ x 4½
6 cyl, 36 – 82 hp @ 1000–2800 rpm, 3¾ x 4¼
6 cyl, 40 – 86 hp @ 1000–2800 rpm, 4 x 4¼
6 cyl, 50 – 90 hp @ 1000–2500 rpm, 4⅛ x 4¾
6 cyl, 53 – 95 hp @ 1000–2500 rpm, 4¼ x 4¾
4 cyl, 37½– 52½ hp @ 1000–1600 rpm, 4¼ x 5¼
6 cyl, 62 –112 hp @ 1000–2250 rpm, 4⅜ x 5⅛
4 cyl, 42½– 58 hp @ 1000–1600 rpm, 4½ x 5¼
6 cyl, 70 –125 hp @ 1000–2250 rpm, 4⅝ x 5⅛
4 cyl, 48 – 68 hp @ 800–1400 rpm, 4¾ x 6¼
6 cyl, 70½–136 hp @ 800–2000 rpm, 5 x 5½
6 cyl, 92 –150 hp @ 1000–2000 rpm, 5 x 5¾
4 cyl, 57 – 79½ hp @ 800–1400 rpm, 5⅛ x 6¼
6 cyl, 82 –155 hp @ 800–2000 rpm, 5½ x 5½
6 cyl, 105 –169 hp @ 800–1600 rpm, 5¾ x 6½
4 cyl, 70½– 91 hp @ 800–1200 rpm, 6 x 6½
6 cyl, 122 –199 hp @ 800–1600 rpm, 6¼ x 6½
6 cyl, 142 –165 hp @ 800–1125 rpm, 6½ x 7
4 cyl, 110 –124 hp @ 800–1050 rpm, 6¾ x 8
6 cyl, 161 –190 hp @ 800–1125 rpm, 7 x 7
6 cyl, 197 –221 hp @ 800–1050 rpm, 7 x 8½
6 cyl, 199 –240 hp @ 800–1050 rpm, 7 x 8½
4 cyl, 145 –173 hp @ 800–1050 rpm, 7½ x 8
6 cyl, 242 –291 hp @ 800–1050 rpm, 7¾ x 8½
6 cyl, 285 –337 hp @ 800–1050 rpm, 8½ x 8½

LISTINGS are as complete and accurate as available information permits, but *Power* assumes no responsibility for errors or omissions. Almost all listings supplied by manufacturers. Abbreviations are: cyl — cylinder, V — vertical, H — horizontal. The two numbers at end of each line are respectively bore and stroke in inches.

In listing number of cylinders, the hyphen (5–8) means that intermediate numbers of cylinders give intermediate horsepower in even steps, the "and" sign (6 & 8) means that only the two sizes are available.

Accessory and Supply Manufacturers

ALARMS & SAFETY CONTROLS
Bendix Aviation Corp, Brooklyn
Delco-Remy Corp, Anderson, Ind.
Diesel Plant Specialties Co, Chicago
Electric Auto-Lite Co, New York
Federal Electric Co, Chicago
Fulton Sylphon Co, Knoxville, Tenn.
Illinois Testing Labs Inc, Chicago
Klaxon Co, Anderson, Ind.
Minneapolis-Honeywell Regulator Co, Minneapolis, Minn.
Strong, Carlisle & Hammond Co, Cleveland
Thomas A Edison Inc, W. Orange, N. J.
Viking Instruments Inc, New York

ANALYZERS, EXHAUST GAS
Bacharach Industrial Instrument Co, Pittsburgh
Electric Auto-Lite Co, New York
Hays Corp, Michigan City, Ind.
Permutit Co, New York

BATTERIES, STORAGE
Electric Auto-Lite Co, New York
Electric Storage Battery Co, Phila.
General Motors Corp, Anderson, Ind.
Gould Storage Battery Co, Depew, N. Y.
Philadelphia Storage Battery Co, Philadelphia
Thomas A Edison Inc, W. Orange, N. J.
USL Battery Corp, Niagara Falls, N. Y.
United States Rubber Co, New York
Willard Storage Battery Co, Cleveland

BEARINGS, ANTI-FRICTION
Aetna Ball Bearing Mfg Co, Chicago
Auburn Ball Bearing Co, Syracuse, N. Y.
Bantam Ball Bearing Corp, South Bend, Ind.
Fafnir Bearing Co, New Britain, Conn.
Gwilliam Co, Brooklyn, N. Y.
Hyatt Roller Bearing Co, Harrison, N. J.
Lamson Co, Syracuse, N. Y.
Link-Belt Co, Chicago
McGill Mfg Co, Valparaiso, Ind.
New Departure Div, Bristol, Conn.
Norma-Hoffman Bearings Corp, Stamford, Conn.
Shafer Bearing Corp, Chicago
SKF Industries Inc, Philadelphia
Timken Roller Bearing Co, Canton, O.
Torrington Co, Torrington, Conn.
Tyson Roller Bearg Corp, Massillon, O.

BEARINGS, SLEEVE
American Bearing Corp, Indianapolis
Bohn Aluminum & Brass Corp, Detroit
Bound Brook Oil-Less Bearing Co, Bound Brook, N. J.
Continental Diamond Fibre Co., Newark, Del.
Farrel-Birmingham Co Inc, Ansonia, Conn.
Fast Bearing Co, Baltimore, Md.
Federal-Mogul Corp, Detroit
Gatke Corp, Chicago (Non-metallic)
General Motors Corp, Dayton, Ohio
Kingsbury Machine Works Inc, Phila.
Nickles Machine Corp, Ponca City, Okla.
Nolu Oilless Bearing Co, Phila.
R W Rhoades Metaline Co, Long Island City, N. Y. (Oilless)
Westinghouse Electric & Mfg Co, East Pittsburgh (Resinoid)

BELTING, FLAT
Alexander Bros Inc, Philadelphia
W D Allen Mfg Co, Chicago
Boston Woven Hose & Rubber Co, Cambridge, Mass.
Chicago Belting Co, Chicago
Chicago Rawhide Mfg Co, Chicago
L H Gilmer Co, Philadelphia
B F Goodrich Co, Akron, Ohio
Goodyear Tire & Rubber Co, Akron
Graton & Knight Co, Worcester, Mass.
Hewitt Rubber Corp, Buffalo, N. Y.
E F Houghton & Co, Philadelphia
Manhattan Rubber Mfg Div, Passaic, N. J.
New York Belting & Packing Co, Passaic, N. J.
Republic Rubber Div, Youngstown, O.
Rockwood Mfg Co, Indianapolis
J E Rhoads & Sons, Philadelphia
Chas A Schieren Co, New York
Thermoid Co, Trenton, N. J.
Ton-Tex Corp, Grand Rapids, Mich.
U S Rubber Co, New York
Victor Balata Belting Co, Easton, Pa.

BELTING, V
Allis-Chalmers Mfg Co, Milwaukee
Chicago Belting Co, Chicago
Dayton Rubber Mfg Co, Dayton, O.
Fairbanks, Morse & Co, Chicago
Gates Rubber Co, Denver, Colo.
L H Gilmer Co, Philadelphia
B F Goodrich Co, Akron, O.
Goodyear Tire & Rubber Co, Akron
Graton & Knight Co, Worcester, Mass.
Manhattan Rubber Mfg Div, Passaic, N. J.
Rockwood Mfg Co, Indianapolis
Chas A Schieren Co, New York
Thermoid Co, Trenton, N. J.
Worthington Pump & Machinery Corp, Harrison, N. J.

BLOWERS, SUPERCHARGING & SCAVENGING
Allen Billmyre Corp, S. Norwalk, Conn.
Allis-Chalmers Mfg Co, Milwaukee
American Blower Corp, Detroit
Buffalo Forge Co, Buffalo, N. Y.
Clarage Fan Co, Kalamazoo, Mich
Coppus Engrg Corp, Worcester, Mass.
Elliott Co, Jeannette, Pa.
General Electric Co, Schenectady
Ingersoll-Rand Co, New York
Roots-Connersville Blower Corp, Connersville, Ind.
Spencer Turbine Co, Hartford, Conn.
B F Sturtevant Co, Hyde Park, Boston
L J Wing Mfg Co, New York

BOILERS, EXHAUST GAS
Alco Products Inc, New York
Babcock & Wilcox Co, New York
Combustion Engrg Co Inc, New York
Davis Engrg Corp, Elizabeth, N. J.
Edge Moor Iron Works Inc, New York
Electric Boat Co, Groton, Conn.
Foster Wheeler Corp, New York
Murray Iron Wks Co, Burlington, Ia.
Sims Co, Erie, Pa.
Struthers-Wells Titusville Corp, Warren, Pa.
Titusville Iron Works, Erie, Pa.
Union Iron Works, Erie, Pa.
Henry Vogt Machine Co, Louisville

CENTRIFUGES, OIL
C F Braun Co, Alhambra, Calif.
De Laval Separator Co, New York
De La Vergne Engine Co, Phila.
Goulds Pumps Inc, Seneca, N. Y.
Sharples Specialty Co, Philadelphia

CHAIN & CHAIN DRIVES
Baldwin-Duckworth Chain Corp, Springfield, Mass.
C O Bartlett & Snow Co, Cleveland
Chain Belt Co, Milwaukee
Diamond Chain & Mfg Co, Indianapolis, Ind.
Filer & Stowell Co, Milwaukee
Gifford-Wood Co, Hudson, N. Y.
Jeffrey Mfg Co, Columbus, O.
Link-Belt Co, Chicago
Morse Chain Co, Ithaca, N. Y.
Ramsey Chain Co Inc, Albany, N. Y.
Stephens-Adamson Mfg Co, Aurora, Ill.
Union Chain & Mfg Co, Sandusky, O.
Whitney Chain & Mfg Co, Hartford, Conn.

CLUTCHES
Allis-Chalmers Mfg Co, Milwaukee
W E Caldwell Co Inc, Louisville, Ky.
Carlyle Johnson Machine Co, Manchester, Conn.
Cutler-Hammer Inc, Milwaukee
Dodge Mfg Corp, Mishawaka, Ind.
FAB Mfg Co, Oakland, Calif.
Fairbanks, Morse & Co, Chicago
Foote Bros Gear & Machine Co, Chicago
Gifford-Wood Co, Hudson, N. Y.
Hill Clutch Machine & Foundry Co, Cleveland, O.
Hilliard Corp, Elmira, N. Y.
Kinney Mfg Co, Boston, Mass.
Link-Belt Co, Chicago
Medart Co, St. Louis
Morse Chain Co, Ithaca, N. Y.
Jos Reid Gas Engine Co, Oil City, Pa.
Reeves Pulley Co, Columbus, Ind.
Rockford Drilling Machine Div, Rockford, Ill.
Stearns Magnetic Mfg Co, Milwaukee
Twin Disc Clutch Co, Racine, Wis.
T B Woods Sons Co, Chambersburg, Pa.

COCKS, CYLINDER
Crane Co, Chicago
Frederick Iron & Steel Co, Frederick, Md.
Jarecki Mfg Co, Erie, Pa.
Lunkenheimer Co, Cincinnati
Manning, Maxwell & Moore Inc, Bridgeport, Conn.
Wm Powell Co, Cincinnati
Walworth Co, New York

COMPRESSORS, AIR
Allis-Chalmers Mfg Co, Milwaukee
Atlas-Imperial Diesel Engine Co, Oaland, Calif.
Binks Mfg Co, Chicago
Bury Compressor Co, Erie, Pa.
Cooper Bessemer Corp, Mt Vernon, O.
Curtis Pneumatic Machinery Co, St. Louis
Chicago Pneumatic Tool Co, New York
Elliott Co, Jeannette, Pa.
Fairbanks, Morse & Co, Chicago
Fuller Co, Catasauqua, Pa.
Gardner-Denver Co, Quincy, Ill.
Globe Mfg Co, Battle Creek, Mich.
Hill Diesel Engine Co, Lansing, Mich.
Ingersoll-Rand Co, New York
Kahlenberg Bros Co, Two Rivers, Wis.
Nash Engineering Co, S. Norwalk, Conn.
Nordberg Mfg Co, Milwaukee
Novo Engine Co, Lansing, Mich
Pennsylvania Pump & Compressor Co, Easton, Pa.
Quincy Compressor Co, Quincy, Ill.
Jos Reid Gas Engine Co, Oil City, Pa.
Roots-Connersville Blower Corp, Connersville, Ind.
Sullivan Machinery Co, Michigan City, Ind.
Westinghouse Air Brake Co, Wilmerding, Pa.
Worthington Pump & Machinery Corp, Harrison, N. J.

CONDENSERS, EVAPORATIVE
American Blower Corp, Detroit
Baker Ice Machine Co Inc, Omaha, Neb.
Buffalo Forge Co, Buffalo, N. Y.
Carrier Engrg Corp, Syracuse, N. Y.
Fairbanks, Morse & Co, Chicago
Frick Co, Waynesboro, Pa.
General Electric Co, Bloomfield, N. J.
Niagara Blower Co, New York
Westinghouse Electric & Mfg Co, East Pittsburgh
Worthington Pump & Machinery Corp, Harrison, N. J.
York Ice Machinery Co, York, Pa.

CONTROL, FREQUENCY

General Electric Co, Schenectady, N. Y.
Leeds & Northrup Co, Philadelphia
Westinghouse Electric & Mfg Co, East Pittsburgh
Woodward Governor Co, Rockford, Ill.

CONTROLLERS, TEMPERATURE

Automatic Temperature Control, Phila.
Bailey Meter Co, Cleveland
Barber-Colman Co, Rockford, Ill.
Bristol Co, Waterbury, Conn.
Brown Instrument Co, Philadelphia
Davis Regulator Co, Chicago
Julian d'Este Co, Boston
Foxboro Co, Foxboro, Mass.
Fulton Sylphon Co, Knoxville, Tenn.
General Controls Co, San Francisco
Johnson Service Co, Milwaukee
Leeds & Northrup Co, Philadelphia
Manning, Maxwell & Moore Inc, Bridgeport, Conn.
Mercoid Corp, Chicago
Minneapolis-Honeywell Regulator Co, Minneapolis, Minn.
Powers Regulator Co, Chicago
Sarco Co, New York
Spence Engrg Co, Walden, N. Y.
Republic Flow Meters Co, Chicago
Ruggles-Klingemann Mfg Co, Salem, Mass.
C J Tagliabue Mfg Co, Brooklyn, N. Y.
Taylor Instrument Cos, Rochester, N. Y.
Thomas A Edison Inc, W. Orange, N. J.
Wheelco Instruments, Chicago

COOLERS, OIL

(see Heat Exchangers)

COOLERS, JACKET WATER

(See Heat Exchangers; Condensers, Evaporative)

COOLING TOWERS

Binks Mfg Co, Chicago
Buffalo Forge Co, Buffalo, N. Y.
Fluor Corp Ltd, Los Angeles
Foster Wheeler Corp, New York
Lilie-Hoffman Cooling Towers Inc, St. Louis
Marley Co, Kansas City, Kan.
Penn Cooling Tower Works, Pittsburgh
J F Pritchard Co, Kansas City, Mo.
Research Corp, New York
Schubert-Christy Corp, St. Louis
C H Wheeler Mfg Co, Philadelphia

COUPLINGS

American Blower Corp, Detroit (Hydraulic couplings)
American Flexible Coupling Co, Erie, Pa.
Ajax Flexible Coupling Co, Westfield, N. Y.
Allis-Chalmers Mfg Co, Milwaukee
Bartlett-Hayward Div, Baltimore, Md.
C O Bartlett & Snow Co, Cleveland
Boston Gear Works, N. Quincy, Mass.
W E Caldwell Co Inc, Louisville, Ky.
Diamond Chain & Mfg Co, Indianapolis
De Laval Steam Turbine Co, Trenton, N. J.
Elliott Co, Jeannette, Pa.
Fairbanks, Morse & Co, Chicago
Falk Co, Milwaukee
Farrel-Birmingham Co Inc, Ansonia, Conn.
Foote Bros Gear & Machinery Co, Chicago
General Electric Co, Schenectady, N. Y.
Hilliard Corp, Elmira, N. Y.
D O James Mfg Co, Chicago
Jeffrey Mfg Co, Columbus, O.
Kinney Mfg Co, Boston
Link-Belt Co, Chicago
Lovejoy Flexible Coupling Co, Chicago
Medart Co, St. Louis
Morse Chain Co, Ithaca, N. Y.
Palmer-Bee Co, Detroit
Poole Foundry & Machine Co, Baltimore, Md.
Robins Conveying Belt Co, New York
Stephens-Adamson Mfg Co, Aurora, Ill.
Thomas Flexible Coupling Co, Warren, Pa.
Watson-Flagg Machine Co, Paterson, N. J.
Westinghouse Electric & Mfg Co, East Pittsburgh

FILTERS, AIR

Air-Maze Corp, Cleveland
American Air Filter Co Inc, Louisville, Ky.
Binks Mfg Co, Chicago
Burgess Battery Co, Madison, Wis.
Coppus Engrg Co, Worcester, Mass.
Donaldson Co Inc, St. Paul, Minn.
Fairbanks, Morse & Co, Chicago
Handy Governor Corp, Detroit
Independent Air Filter Co Inc, Chicago
Owens-Illinois Glass Co, Toledo, O.
Skinner Purifiers Inc, Detroit
Staynew Filter Corp, Rochester, N. Y.
United Air Cleaner Corp, Chicago
Vortox Mfg Co, Claremont, Calif.

FILTERS, OIL

A-C Spark Plug Div, Flint, Mich.
American Bosch Corp, Springfield, Mass.
S F Bowser & Co, Fort Wayne, Ind.
Bousman Mfg Co Inc, Grand Rapids, Mich.
Briggs Clarifier Co, Washington, D. C.
Burt Mfg Co, Akron, Ohio
A W Cash Co, Decatur, Ill.
Commercial Filters Corp, Boston
Cuno Engrg Corp, Meriden, Conn.
De Laval Separator Co, New York
De La Vergne Engine Co, Philadelphia.
De Luxe Products Corp, La Porte, Ind.
Diesel Filter Co, Astoria, Ore.
Diesel Equipment Co, Chicago
Dushane Co Inc, Detroit
Elliott Co, Jeannette, Pa.
Fairbanks, Morse & Co, Chicago
Fleming Mfg Co, E. Providence, R. I.
Goulds Pumps Inc, Seneca, N. Y.
Handy Governor Corp, Detroit
Hilliard Corp, Elmira, N. Y.
Michiana Products Corp, Michigan City, Ind.
Motor Improvements, Inc, Newark, N. J.
Wm W Nugent & Co Inc, Chicago
Neptune Meter Co, New York
Schutte & Koerting Co, Philadelphia
Sharples Specialty Co, Philadelphia
Skinner Purifiers Inc, Detroit
Staynew Filter Corp, Rochester, N. Y.
Youngstown Miller Co, Sandusky, O.
Zenith Carburetor Corp, Detroit
Worthington Pump & Machinery Corp, Harrison, N. J.

FILTERS, WATER

American Water Softener Co, Phila.
Cochrane Corp, Philadelphia
Cuno Engrg Co, Meriden, Conn.
Elgin Softener Corp, Elgin, Ill.
Elliott Co, Jeannette, Pa.
Graver Tank & Mfg Co, E. Chicago, Ind.
Hungerford & Terry Inc, Clayton, N. J.
International Filter Co, Chicago
Loomis Manning Filter Mfg Co, Phila.
Norwood Engrg Co, Florence, Mass.
Permutit Co, New York
Power Plant Specialty Co, Chicago
Roberts Filter Mfg Co, Darby, Pa.
Wm B Scaife & Sons, Oakmont, Pa.
Skinner Purifiers Inc, Detroit
Zeolite Engrg Corp, Chicago

GAGES, PRESSURE

American Meter Co, Brooklyn, N. Y.
Ashton Valve Co, Cambridge, Mass.
Bacharach Industrial Instrument Co, Pittsburgh
Bailey Meter Co, Cleveland
H Belfield Co, Philadelphia
Bristol Co, Waterbury, Conn.
Brown Instrument Co, Philadelphia
Crane Co, Chicago
Crosby Steam Gauge & Valve Co, Boston
Detroit Lubricator Co, Detroit
C A Dunham Co, Chicago
Electric Auto-Lite Co, New York
Esterline-Angus Co, Indianapolis
Foxboro Co, Foxboro, Mass.
Hays Corp, Michigan City, Ind.
J E Lonergan Co, Philadelphia
Mercoid Corp, Chicago
Manning, Maxwell & Moore Inc, Bridgeport, Conn.
Mason-Neilan Regulator Co, Boston
Marshalltown Mfg Co, Marshalltown, Iowa
Republic Flow Meters Co, Chicago
Rochester Mfg Co Inc, Rochester, N. Y.
C J Tagliabue Mfg Co, Brooklyn
Taylor Instrument Cos, Rochester, N. Y.
Uehling Instrument Co, Paterson, N. J.
U S Gauge Co, New York
Viking Instruments Inc, New York

GAGES, STRAIN

Baldwin-Southwark Corp, Philadelphia
Hartford Steam Boiler Inspection & Insurance Co, Hartford, Conn.
Pratt & Whitney Div, Hartford
L S Starrett, Athol, Mass.

GAGES, TANK

Bailey Meter Co, Cleveland
Binks Mfg Co, Chicago
W E Caldwell Co Inc, Louisville, Ky.
Crane Co, Chicago
Detroit Lubricator Co, Detroit
Foxboro Co, Foxboro, Mass.
Johnston & Jennings Co, Cleveland
King Engrg Co, Ann Arbor, Mich.
Leeds & Northrup Co, Philadelphia
Liquidometer Corp, Long Island City, N. Y.
Lunkenheimer Co, Cincinnati
Manning, Maxwell & Moore Inc, Bridgeport, Conn.
Morey-Jones Ltd, Los Angeles, Calif.
Petrometer Co, Long Island City, N. Y.
Pneumercator Co Inc, New York
Republic Flow Meters Co, Chicago
Rochester Mfg Co Inc, Rochester, N. Y.
Uehling Instrument Co, Paterson, N. J.
Viking Pump Co, Cedar Falls, Iowa

GASKETS & PACKING

Acme Mfg & Gasket Co, Philadelphia
Akron Metallic Gasket Co, Akron, O.
Allpax Co Inc, Mamaroneck, N. Y.
American Felt Co, New York
Anchor Packing Co, Philadelphia
Armstrong Cork Products Co, Lancaster, Pa.
Belmont Packing & Rubber Co, Phila.
Booth Felt Co, Brooklyn, N. Y.
Philip Carey Co, Lockland, Ohio
A W Chesterton Co, Boston
Cincinnati Gasket & Packing Co, Cincinnati
Cincinnati Rubber Mfg Co, Cincinnati
Consolidated Packing & Supply Co, N. Y.
C Lee Cook Mfg Co, Louisville, Ky.
Crandall Packing Co, Palmyra, N. Y.
Crane Packing Co, Chicago
Darcoid Co Inc, New York
Detroit Gasket & Mfg Co, Detroit
Durabla Mfg Co, New York
E I du Pont de Nemours & Co, Wilmington, Del (Chloroprene)
Durametallic Corp, Kalamazoo, Mich.
Ehret Magnesia Mfg Co, Valley Forge, Pa.
Endura Mfg Corp, Quakertown, Pa.
Eureka Packing Co, Brooklyn, N. Y.
Felt Products Mfg Co, Chicago
Flexitallic Gasket Co, Camden, N. J.
France Packing Co, Philadelphia
Garlock Packing Co, Palmyra, N. Y.
Gatke Corp, Chicago
Goetze Gasket & Packing Co Inc, New Brunswick, N. J.
Goodall Rubber Co, Philadelphia
B F Goodrich Co, Akron, Ohio
Goodyear Tire & Rubber Co, Akron
Graton & Knight Co, Worcester, Mass.
Greene, Tweed & Co, New York
E F Houghton & Co, Philadelphia
Huhn Mfg Co, New York
Janos Asbestos Co, New York
Jenkins Bros, New York
Johns-Manville, New York
Keasbey & Mattison Co, Ambler, Pa.
Klingerit Inc, New York
Manhattan Rubber Mfg Div, Passaic, N. J.
McCord Radiator & Mfg Co, Detroit
Metallo Gasket Co, New Brunswick, N. J.
National Vulcanized Fibre Co, Wilmington, Del.
New York Belting & Packing Co, Passaic, N. J.
Phoenix Specialty Mfg Co, New York
Quaker City Rubber Co, Philadelphia
Rains Metallic Packing Co, Spokane, Wash.
Raybestos-Manhattan, Bridgeport, Conn.
Republic Rubber Div, Youngstown, O.
John R. Robinson, New York
Chas A Schieren Co, New York
Smooth-On Mfg Co, Jersey City, N. J.
Standard Packings Co, Cleveland
Thermoid Co, Trenton, N. J.
Tripp Metallic Packing Co, Boston
U S Metallic Packing Co, Phila.
U S Rubber Co, New York
Union Asbestos & Rubber Co, Chicago
Vellumoid Co, Worcester, Mass.
Victor Mfg & Gasket Co, Chicago
J Walker Packing Co, New York
Walker Metallic Packing Co, Phila.
John M Watts Sons, Philadelphia
Watson-Stillman Co, Roselle, N. J.
Western Felt Works, Chicago
Western Gasket & Mfg Co, Los Angeles

GEARING

Allis-Chalmers Mfg Co, Milwaukee
C O Bartlett & Snow Co, Cleveland
Boston Gear Works, N. Quincy, Mass.
Bridgeport Worm & Gear Co, Bridgeport, Conn.
Cleveland Worm & Gear Co, Cleveland
Falk Corp, Milwaukee
Farrel-Birmingham Co, Ansonia, Conn.
Foote Bros Gear & Machine Co, Chicago
Gatke Corp, Chicago
General Electric Co, Schenectady, N. Y.
Grant Gear Works, Boston
D O James Mfg Co, Chicago
W A Jones Foundry & Machine Co, Chicago
Lewis Foundry & Machine Div, Pittsburgh
Link-Belt Co, Chicago
Medart Co, St. Louis
Philadelphia Gear Works, Phila.
Pittsburgh Gear & Machine Co, Pittsburgh
Poole Foundry & Machine Co, Baltimore, Md.
Stephens-Adamson Mfg Co, Aurora, Ill.
Strganahan Gear Co, Philadelphia
Terry Steam Turbine Co, Hartford, Conn.
Twin Disc Clutch Co, Racine, Wis.
Westinghouse Electric & Mfg Co, East Pittsburgh
Worthington Pump & Machinery Corp, Harrison, N. J.
Wyman-Gordon Co, Worcester, Mass.

GENERATORS & EXCITERS

Allis-Chalmers Mfg Co, Milwaukee
Louis Allis Co, Milwaukee
Century Electric Co, St. Louis
Columbia Electric Mfg Co, Cleveland
Crocker-Wheeler Electric Mfg Co, Ampere, N. J.
Diehl Mfg Co, Elizabethport, N. J.
Electric Machinery Mfg Co, Minneapolis, Minn.
Elliott Co, Jeannette, Pa.
Fairbanks, Morse & Co, Chicago
General Electric Co, Schenectady, N. Y.
Ideal Electric & Mfg Co, Mansfield, O.
Reliance Electric Engrg Co, Cleveland
Star Electric Motor Co, Bloomfield, N. J.
Westinghouse Electric & Mfg Co, East Pittsburgh

GOVERNORS

American Bosch Corp, Springfield, Mass.
Handy Governor Corp, Detroit
Massey Machine Co, Watertown, N. Y.
Pickering Governor Co, Portland, Conn.
Pierce Governor Co, Anderson, Ind.
Woodward Governor Co, Rockford, Ill.

GREASE

(See Oil, Lubricating)

HEAT EXCHANGERS

Alberger Heater Co, Buffalo, N. Y.
Alco Products Inc, New York
Allis-Chalmers Mfg Co, Milwaukee
Andale Co, Philadelphia
Babcock & Wilcox Co, New York
Binks Mfg Co, Chicago
Buffalo Forge Co, Buffalo, N. Y.
Combustion Engrg Co Inc, New York
Croll Reynolds Engrg Co, New York
Davis Engrg Co, Elizabeth, N. J.
Edge Moor Iron Works Inc, New York
Elliott Co, Jeannette, Pa.
Fluor Corp Ltd, Los Angeles
Foster Wheeler Corp, New York
General Electric Co, Schenectady, N. Y.
G & O Mfg Co, New Haven, Conn.
Goulds Pumps Inc, Seneca, N. Y.
Griscom-Russell Co, New York
Gross Mech Labs Inc, Baltimore, Md.
Harrison Radiator Div, Lockport, N. Y.
Heat Exchanger Co, Grove City, Pa.
Heilman Boiler Works, Allentown, Pa.
Henszey Co, Watertown, Wis.
Ingersoll-Rand Co, New York
Lilie-Hoffman Cooling Towers Inc, St Louis
M W Kellogg Co, Jersey City, N. J.
Marley Co, Kansas City, Kan.
Patterson-Kelly Co, E Stroudsburg, Pa.
J F Pritchard & Co, Kansas City, Mo.
Rome-Turney Radiator Co, Rome, N. Y.
Ross Heater & Mfg Co, Buffalo, N. Y.
Schubert-Christy Corp, St. Louis
Schutte & Koerting Co, Philadelphia
Sims Co, Erie, Pa.
Geo L Squier Mfg Co, Buffalo, N. Y.
Struthers-Wells Titusville Corp, Warren, Pa.
B F Sturtevant Co, Hyde Park, Boston
Henry Vogt Machine Co, Louisville, Ky.
Westinghouse Electric & Mfg Co, East Pittsburgh
Western Gas Div, Fort Wayne, Ind.
C H Wheeler Co, Philadelphia
Whitlock Coil Pipe Co, Hartford, Conn.
Worthington Pump & Machinery Corp, Harrison, N. J.
York Ice Machinery Co, York, Pa.
Young Radiator Co, Racine, Wis.
Zenith Carburetor Corp, Detroit

HOSE, FLEXIBLE METALLIC

American Brass Co, Waterbury, Conn.
Atlantic Metal Hose Co Inc, New York
Breeze Corp Inc, Newark, N. J.
Chicago Metal Hose Corp, Maywood, Ill.
Federal Metal Hose Corp, Buffalo, N. Y.
Flex-O-Tube Co, Detroit
Pennsylvania Flexible Metallic Tubing Co, Philadelphia
Ingersoll-Rand Co, New York
Seamless Corp, Long Island City, N. Y.
Titeflex Metal Hose Co, Newark, N. J.
United Metal Hose Co Inc, New York
Weatherhead Co, Cleveland

HOSE, OIL-PROOF, RUBBER

Boston Woven Hose & Rubber Co, Cambridge, Mass.
Cincinnati Rubber Mfg Co, Cincinnati
Continental Rubber Works, Erie, Pa.
Gates Rubber Co, Denver, Colo.
Goodall Rubber Co, Philadelphia
B F Goodrich Co, Akron, Ohio

Goodyear Tire & Rubber Co, Akron
Manhattan Rubber Mfg Div, Passaic, N. J.
New York Belting & Packing Co, Passaic, N. J.
Quaker City Rubber Co, Philadelphia
Raybestos-Manhattan Inc, Bridgeport, Conn.
Republic Rubber Div, Youngstown, O.
Thermoid Co, Trenton, N. J.
U S Rubber Co, New York

INDICATORS, ENGINE

Bacharach Industrial Instrument Co, Pittsburgh
K J DeJuhasz, State College, Pa.
De La Vergne Engine Co, Philadelphia
Trill Indicator Co, Corry, Pa.
Wheelco Instruments Co, Chicago

INDICATORS, SPEED

Bacharach Industrial Instrument Co, Pittsburgh
Bailey Meter Co, Cleveland
James G Biddle Co, Philadelphia
Bristol Co, Waterbury, Conn.
Brown Instrument Co, Philadelphia
Electric Tachometer Corp, Phila.
Esterline-Angus Co, Indianapolis
Foxboro Co, Foxboro, Mass.
Leeds & Northrup Co, Philadelphia
Manning, Maxwell & Moore, Inc, Bridgeport, Conn.
Veeder-Root Inc, Hartford, Conn.
O Zernickow Co, New York

INDICATORS, SIGHT-FLOW

Lunkenheimer Co, Cincinnati
Wm W Nugent & Co Inc, Chicago
Parker Appliance Co, Cleveland
Schutte & Koerting Co, Philadelphia

INJECTION SYSTEMS, FUEL

American Bosch Corp, Springfield, Mass.
Diesel Equipment Corp, Chicago
Ex-Cell-O Aircraft & Tool Corp, Detroit
Murphy Diesel Co, Ltd, Milwaukee
Timken Roller Bearing Co, Canton, O.
Viking Pump Co, Cedar Falls, Iowa

INSTRUMENTS, ELECTRIC

Bendix Aviation Corp, Brooklyn
James G Biddle Co, Philadelphia
Bristol Co, Waterbury, Conn.
Brown Instrument Co, Philadelphia
Columbia Electric Mfg Co, Cleveland
Duncan Electric Mfg Co, Lafayette, Ind.
Thomas A Edison Inc, W. Orange, N. J.
Esterline-Angus Co, Indianapolis
General Electric Co, Schenectady, N. Y.
Leonard Electric Mfg Co, Cleveland
Leeds & Northrup Co, Philadelphia
Roller-Smith Co, New York
Westinghouse Electric & Mfg Co, East Pittsburgh
Weston Electrical Instrument Corp, Newark, N. J.
Wheelco Instruments Co, Chicago

INSTRUMENT PANELS, ENGINE

Electric Auto-Lite Co, New York
Jones Motrola Sales Co, New York
Viking Instruments Inc, New York

INSULATION, SOUND & HEAT

Armstrong Cork Products Co, Lancaster, Pa.
Burgess Battery Co, Madison, Wis.
Philip Carey Co, Lockland, Ohio
Cork Insulation Co, New York
Eagle-Picher Lead Co, Cincinnati
Johns-Manville, New York
Keasbey & Mattison Co., Ambler, Pa.
Owens-Illinois Glass Co, Toledo, O.
U S Gypsum Co, Chicago

JOINTS, EXPANSION

American District Steam Co, N. Tonawanda, N. Y.
E B Badger & Sons Co, Boston
Philip Carey Co, Lockland, Ohio
Crane Co, Chicago
Croll Reynolds Engrg Co, New York
Direct Separator Co, Syracuse, N. Y.
S R Dresser Mfg Co, Bradford, Pa.
Foster Wheeler Corp, New York
Goodyear Tire & Rubber Co, Akron, Ohio
Griscom-Russell Co, New York
Jarecki Mfg Co, Erie, Pa.
Jos Kopperman & Sons, Phila.
Pennsylvania Metallic Tubing Co, Philadelphia
Wm Powell Co, Cincinnati, O.
Walworth Co, New York
C H Wheeler Co, Philadelphia
Yarnall-Waring Co, Philadelphia

JOINTS, FLEXIBLE

American Brass Co, Waterbury, Conn.
Atlas Valve Co, Newark, N. J.
Barco Mfg Co, Chicago
H Belfield Co, Philadelphia
L J Bordo Co Inc, Glenside, Pa.
Jarecki Mfg Co, Erie, Pa.
Wm Powell Co, Cincinnati, O.
Taylor Forge & Pipe Works, Chicago
United Metal Hose Co, Long Island City, N. Y.
U S Pipe & Foundry Co, Burlington, N. J.

LUBRICATORS

American Bosch Corp, Springfield, Mass.
Bijur Lubricating Corp, Long Island City, New York
Bowen Products Corp, Auburn, N. Y.
S F Bowser & Co Inc, Fort Wayne, Ind.
Detroit Lubricator Co, Detroit
Greene, Tweed & Co, New York
Ideal Lubricator Co, Philadelphia
Jarecki Mfg Co, Erie, Pa.
J E Lonergan Co, Philadelphia
Lunkenheimer Co, Cincinnati
Madison-Kipp Corp, Madison, Wis.
Manzel Bros Co, Buffalo, N. Y.
McCord Radiator Mfg Co, Detroit
Nathan Mfg Co, New York
Wm W Nugent & Co, Chicago
Wm Powell Co, Cincinnati
Quimby Pump Co, Newark, N. J.
Stewart-Warner Co, Chicago
Torrington Mfg Co, Torrington, Conn.
U S Metallic Packing Co, Philadelphia
Victor Lubricator Co, Chicago

MANIFOLDS, SILENCING

Burgess Battery Co, Madison, Wis.
Detroit Gasket & Mfg Co, Detroit
Maxim Silencer Co, Hartford, Conn.
Porcupine Co, Bridgeport, Conn.
U S Metal Hose Co, Long Island City, N. Y.
Weber Engine Co, Kansas City, Mo.
Wright-Austin Co, Detroit

MANOMETERS

American Blower Corp, Detroit
American Instrument Co, Silver Springs, Md.
Bacharach Industrial Instrument Co, Pittsburgh
Bailey Meter Co, Cleveland
Brown Instrument Co, Philadelphia
Defender Automatic Regulator Co, St. Louis
Ellison Draft Gage Co, Chicago
Hays Corp, Michigan City, Ind.
Manning Maxwell & Moore Inc, Bridgeport, Conn.
Meriam Co, Cleveland
Republic Flow Meters Co, Chicago
Scientific Instrument Co, Detroit
Schutte & Koerting Co, Philadelphia
Simplex Valve & Meter Co, Phila.

METERS, WATER OR OIL

American Meter Co, New York
Anthony Co, Long Island City, N. Y.
Bailey Meter Co, Cleveland
Brown Instrument Co, Philadelphia
S F Bowser & Co Inc, Fort Wayne, Ind.
Buffalo Meter Co, Buffalo, N. Y.
Builders Iron Foundry, Providence
Cochrane Corp, Philadelphia
Crane Co, Chicago
Elgin Softener Corp, Elgin, Ill.
Fischer & Porter Co, Philadelphia
Foxboro Co, Foxboro, Mass.
Henszey Co, Watertown, Wis.
Hersey Mfg Co, Boston
National Meter Co, Brooklyn, N. Y.
Neptune Meter Co, Long Island City, N. Y.
Pittsburgh Equitable Meter Co, Pittsburgh
Republic Flow Meters Co, Chicago
Roots-Connersville Blower Corp, Connersville, Ind.
Simplex Valve & Meter Co, Phila.
Schutte & Koerting Co, Philadelphia
Taylor Instrum. Cos, Rochester, N.Y.
Worthington Pump & Machinery Corp, Harrison, N. J.
Yarnall-Waring Co, Philadelphia

MUFFLERS, INTAKE & EXHAUST

Burgess Battery Co, Madison, Wis.
Donaldson Co, Inc, St. Paul, Minn.
Engineering Specialties Co, New York
Foster Wheeler Corp, New York
Maxim Silencer Co, Hartford, Conn.
Porcupine Co, Bridgeport, Conn.
Jos Reid Gas Engine Co, Oil City, Pa.
Staynew Filter Corp, Rochester, N. Y.
United Metal Hose Co, Long Island City, N. Y.
Weber Engine Co, Kansas City, Mo.
Worthington Pump & Machinery Corp, Harrison, N. J.
Wright-Austin Co, Detroit

OIL, FUEL & LUBRICATING

Acheson Colloids Corp, Port Huron, Mich. (Colloidal Graphite)
Atlantic Refining Co, Philadelphia
Barnsdall Refining Corp, Tulsa, Okla.
Borne-Scrymser Co, New York
Chard & Howe, Brooklyn, N. Y.
Cities Service Co, New York
Continental Oil Co, Ponca City, Okla.
Adam Cook's Sons Co, Linden, N. J.
Deep Rock Oil Corp, Tulsa, Okla.
Diesel Oil Co, Corpus Christi, Tex.
Jos Dixon Crucible Co, Jersey City, N. J. (Graphite)
Franklin Oil & Gas Co, Bedford, Ohio
Galena Oil Corp, Cincinnati
Gulf Oil Corp, Pittsburgh
Haggerty Refining Co, New York
A W Harris Oil Co, Providence, R. I.
E F Houghton & Co, Philadelphia
Hulburt Oil & Grease Co, Phila.
Ilsley, Doubleday & Co, Brooklyn
Indian Refining Co, Indianapolis
Johnson Oil Refining Co, Chicago
Keystone Lubricating Co, Phila.
Lion Oil Refining Co, El Dorado, Ark.
Lubal Co, Columbus, Ohio (Concentrate)
Lubriplate Corp, New York
Macmillan Petroleum Corp, Los Angeles
Marathon Oil Co, Tulsa, Okla.
W B McVicker Co, Brooklyn, N. Y.
Metalene Chemical Co, Cleveland
MidContinent Petroleum Corp, Chicago
Nassau Laboratories, New York (Colloidal graphite)
National Refining Co, Cleveland
Ohio Grease Co, Loudonville, Ohio
Pennzoil Corp, Oil City, Pa.
Petroleum Heat & Power Co, Stamford, Conn.
Phillips Petroleum Co, Bartlesville, Okla.
Pure Oil Co, Chicago
Pyroil Co, La Crosse, Wis. (Concentrate).
Richfield Oil Corp, New York
Shell Oil Co, San Francisco
Shell Petroleum Corp, St. Louis
Shell Union Oil Corp, New York
Sinclair Refining Co, New York
Socony-Vacuum Corp, New York
L Sonneborn Sons, New York
Standard Oil Co (Indiana), Chicago
Standard Oil Co (Calif.), Los Angeles
D A Stuart Oil Co Ltd, Chicago
Stewart-Warner Corp, Chicago
Sun Oil Co, Philadelphia
Swan-Finch Oil Corp, New York
Texas Petroleum Products Co, San Antonio, Texas
Texas Co, New York
Tidewater Assoc. Oil Co, New York
Valvoline Oil Co, Cincinnati
Waverly Oil Works, Pittsburgh
White & Bagley Co, Worcester, Mass.

OIL-RECLAMATION SYSTEMS

Briggs Clarifier Co, Washington, D. C.
De La Vergne Engine Co, Philadelphia
Goulds Pumps Inc, Seneca, N. Y.
Hilliard Corp, Elmira, N. Y.
Wm W Nugent & Co, Inc, Chicago
Skinner Purifiers Inc, Detroit
Youngstown Miller Co, Sandusky, Ohio

PACKING

(See Gasets & Packing)

PIPE & FITTINGS

American Brass Co, Waterbury, Conn.
B F Shaw Co, Wilmington, Del.
Bethlehem Steel Co, Bethlehem, Pa.
Bonney Forge & Tool Works, Allentown, Pa.
Boston Woven Hose & Rubber Co, Cambridge, Mass.
Blaw-Knox Co, Pittsburgh
A M Byers Co, Pittsburgh
Chase Brass & Copper Co, Waterbury, Conn.
Crane Co, Chicago
Foster Wheeler Corp, New York
E M Dart Mfg Co, Providence, R. I.
Grinnell Co, Providence, R. I.
Homestead Valve & Mfg Co, Coraopolis, Pa.
Jarecki Mfg Co, Erie, Pa.
Jefferson Union Co, New York
Jones & Laughlin Steel Corp, Pittsburgh
E F Keating Pipe Bending & Supply Co, New York
M W Kellogg Co, Jersey City, N. J.
Geo B Limbert & Co, Chicago
Lunkenheimer Co, Cincinnati
Maryland Pipe & Steel Corp, Baltimore, Md.
Midwest Piping & Supply Co, St. Louis
Mueller Co, Decatur, Ill.
Mueller Brass Co, Port Huron, Mich.
National Tube Co, Pittsburgh
National Valve & Mfg Co, Pittsburgh
Naylor Pipe Co, Chicago
Wm W Nugent & Co Inc, Chicago
Parker Appliance Co, Cleveland
Pennsylvania Forge Co, Philadelphia
Pittsburgh Piping & Equipment Co, Pittsburgh
Pittsburgh Valve & Fittings Co, Barberton, Ohio
Pittsburgh Steel Co, Pittsburgh
Reading Iron Co., Reading, Pa.
Reading-Pratt & Cady Div, Bridgeport, Conn.
Republic Steel Corp, Youngstown, O.
Revere Copper & Brass Inc, New York
Rockwood Sprinkler Co, Worcester, Mass.
John Simmons Co, Long Island City, N. Y.
Scoville Mfg Co, Waterbury, Conn.
Stockham Pipe & Fitting Co, Birmingham, Ala.
Taylor Forge & Pipe Works, Chicago
Tube-Turns Inc, Louisville, Ky.
U. S. Steel Corp, Pittsburgh
United Metal Hose Co, New York
Henry Vogt Machine Co, Louisville
Watson-Stillman Co, Roselle, N. J.
Walworth Co Inc, New York
Weatherhead Co, Cleveland
Wheeling Steel Corp, Wheeling, W. Va.
Wolverine Tube Co, Detroit
Youngsfown Sheet & Tube Co, Youngstown, Ohio

PISTON RINGS

A Allen & Sons, Harrison, N. J.
Aluminum Industries Inc, Cincinnati
American Hammered Piston Ring Div, Baltimore, Md.
Arrow Head Steel Products Co, Minneapolis, Minn.
Auto-Diesel Piston Ring Co, Cleveland
Burd Piston Ring Co, Rockford, Ill.
Bi-Metal Piston Ring Corp, New York
C Lee Cook Mfg Co, Louisville, Ky.
Double-Seal Ring Corp, New York
Hunt-Spiller Mfg Co, So. Boston
International Piston Ring Co, Cleveland
Kropp Forge Co, Chicago, Ill.
McQuay-Norris Mfg Co, St. Louis, Mo.
Muskegon Piston Ring Co, Muskegon, Mich.
Perfect Circle Co, Hagerstown, Md.
Richardson Co, Melrose Park, Ill.
Richmond Ring Co, Souderton, Pa.
Sealed Power Corp, Muskegon, Mich.
Skinner Chuck Co, New Britain, Conn.
Superior Piston Ring Co, Chicago
Thompson Products Inc, Cleveland
A P Ward Inc, Cincinnati
Wil-Ever Piston Ring Co, Toledo, O.

PUMPS, FUEL INJECTION

American Bosch Corp, Springfield, Mass.
Diesel Equipment Corp, Chicago
Ex-Cell-O Aircraft & Tool Corp, Detroit
Kinney Mfg Co, Boston
Geo D Roper Corp, Rockford, Ill.
Timken Roller Bearing Co, Canton, O.

PUMPS, GENERAL SERVICE, OIL AND WATER

Aldrich Pump Co, Allentown, Pa.
Allis-Chalmers Mfg Co, Milwaukee
American Marsh Pumps Inc, Battle Creek, Mich.
Aurora Pump Mfg Co, Aurora, Ill.
Beach-Russ Co, New York
Becker Pump Co Inc, Emeryville, Calif.
Blackmer Pump Co, Grand Rapids, Mich.
Buffalo Pumps, Inc, Buffalo, N. Y.
Byron Jackson Co, Berkeley, Calif.
Columbia Pump Co, Emeryville, Calif.
M T Davidson Co, New York
Dayton-Dowd Co, Quincy, Ill.
Dean Bros Co, Indianapolis
Dean-Hill Pump Co, Anderson, Ind.
De Laval Steam Turbine Co, Trenton, N. J.
Deming Co, Salem, Ohio
Dow Pump & Diesel Engine Co, Alameda, Calif.
Evans Appliance Co, Detroit
Fairbanks, Morse & Co, Chicago
Foster Wheeler Corp, New York
Gardner-Denver Co, Quincy, Ill.
Goulds Pumps Inc, Seneca Falls, N. Y.
Hercules Roller Pump Co, San Francisco
Ingersoll-Rand Co, New York
Kinney Mfg Co, Boston
Kraissl Co Inc, Hackensack, N. J.
Lawrence Machine & Pump Co, Lawrence, Mass.
Lawrence Pump & Engine Co, Lawrence, Mass.
Lobee Pump & Mach'y Co, Buffalo
Madison-Kipp Corp, Madison, Wis.
Manzel Bros Co, Buffalo, N. Y.
Morris Machine Works, Baldwinsville, N. Y.
Micro-Westco Inc, Bettendorf, Iowa
Nash Engineering Co, S. Norwalk, Conn.
National Transit Pump & Machine Co, Oil City, Pa.
Northern Pump Co, Algona, Iowa
Wm W Nugent & Co Inc, Chicago
Quimby Pump Co, Newark, N. J.
Geo D Roper Corp, Rockford, Ill.
Roots-Connersville Blower Corp, Connersville, Ind.
Rumsey Pump Co, Seneca Falls, N. Y.
Schutte & Koerting Co, Philadelphia
Tuthill Pump Co, Chicago
Union Steam Pump Co, Battle Creek, Mich.
Viking Pump Co, Cedar Falls, Iowa
Henry Vogt Machine Co, Louisville
Warren Steam Pump Co, Warren, Mass.
Worthington Pump & Machinery Corp, Harrison, N. J.

PYROMETERS

Bailey Meter Co, Cleveland
Bristol Co, Waterbury, Conn.
Brown Instrument Co, Philadelphia
Defender Automatic Regulator Co, St. Louis

Chase Engelhard Inc, Newark, N. J.
Foxboro Co, Foxboro, Mass.
Illinois Testing Labs Inc, Chicago
Leeds & Northrup Co, Philadelphia
Roller-Smith Co, New York
C J Tagliabue Mfg Co, Brooklyn, N. Y.
Taylor Instrument Cos, Rochester, N. Y.
Thwing-Albert Instrument Co, Phila.
Uehling Instrument Co, Paterson, N. J.
Wheelco Instruments Co, Chicago

RADIATORS

American Radiator Co, New York
G & O Mfg Co, New Haven, Conn.
Harrison Radiator Div, Lockport, N. Y.
Perfex Radiator Co, Milwaukee
Rome-Turney Radiator Co, Rome, N. Y.
McCord Radiator & Mfg Co, Detroit
Yates American Machine Co, Beloit, Wis.
Young Radiator Co, Racine, Wis.

RECORDERS, TEMP, PRESS, ETC

Bailey Meter Co, Cleveland
Bristol Co, Waterbury, Conn.
Brown Instrument Co, Philadelphia
Crosby Steam Gage & Valve Co, Boston
Defender Automatic Regulator Co, St. Louis
Electric Auto-Lite Co, New York
Chas Engelhard, Newark, N. J.
Esterline-Angus Co, Indianapolis
Foxboro Co, Foxboro, Mass.
General Electric Co, Schenectady, N. Y.
Hays Corp, Michigan City, Ind.
Leeds & Northrup Co, Philadelphia
Liquidometer Corp, Long Island City, N. Y.
Manning, Maxwell & Moore Inc, Bridgeport, Conn.
Powers Regulator Co, Chicago
Republic Flow Meters Co, Chicago
Roller-Smith Co, New York
C J Tagliabue Mfg Co, Brooklyn, N. Y.
Taylor Instrument Cos, Rochester, N. Y.
Uehling Instrument Co, Paterson, N. J.
U S Gage Co, New York
Westinghouse Electric & Mfg Co, East Pittsburgh

REGULATORS, VOLTAGE

Allis-Chalmers Mfg Co, Milwaukee
Cutler-Hammer Inc, Milwaukee
General Electric Co, Schenectady, N. Y.
Ideal Commutator Dresser Co, Syracuse, Ill.
Leeds & Northrup Co, Philadelphia
Roller-Smith Co, New York
Ward Leonard Electric Co, Mt. Vernon, N. Y.
Westinghouse Electric & Mfg Co, East Pittsburgh

REPAIRS

Brodie System Inc, Brooklyn
Brownell Co, Dayton, Ohio
Diesel Engine Service, New York
Diesel Plant Specialties Co, Chicago
Electric Boat Co, Groton, Conn.
Fairbanks, Morse & Co, Chicago
Frazier Wright Co Ltd, Los Angeles
Nickles Machine Corp, Ponca City, Okla.
Nordberg Mfg Co, Milwaukee
Washington Iron Works, Sherman, Tex.

SHIMS

Keystone Gasket Mfg Co, Philadelphia
Laminated Shim Co, Long Island City, N. Y.
National Motor Bearing Co Inc, Oakland, Calif.
Phoenix Specialty Co, New York
Thomas & Skinner Steel Products Co, Indianapolis
Victor Mfg & Gasket Co, Chicago
Whitehead Stamping Co, Detroit

SPRAY NOZZLES, COOLING POND

Aldrich Pump Co, Allentown, Pa.
American Blower Corp, Detroit
Anthony Co, Long Island City, N. Y.
Binks Mfg Co, Chicago
Buffalo Forge Co, Buffalo, N. Y.
Edwin Burhorn Co, Hoboken, N. J.
Detroit Lubricator Co, Detroit
Fluor Corp, Los Angeles
Marley Co, Kansas City, Mo.
Monarch Mfg Works, Philadelphia
Penn Cooling Tower Works, Pittsburgh
Schubert-Christy Corp, St. Louis
Schutte & Koerting Co, Philadelphia
Spray Engrg Co, Somerville, Mass.
Yarnall-Waring Co, Philadelphia

STRAINERS

American District Steam Co, N. Tonawanda, N. Y.
Andale Co, Philadelphia
Anthony Co, Long Island City, N. Y.
Atwood-Morrill Co, Salem, Mass.
Blackburn-Smith Corp, Hoboken, N. J.
Buffalo Meter Co, Buffalo, N. Y.
A W Cash, Decatur, Ill.
Cochrane Corp, Philadelphia
Cuno Engrg Co, Meriden, Conn.
Crane Co, Chicago
Davis Regulator Co, Chicago
Edward Valve & Mfg Co, E. Chicago, Ind.
Elliott Co, Jeanette, Pa.
Fisher Governor Co, Marshalltown, Ia.
Foster Engrg Co, Newark, N. J.
Grinnell Co, Providence, R. I.
Kieley & Mueller Inc, New York
Kinney Mfg Co, Boston
Lunkenheimer Co, Cincinnati
Manning, Maxwell & Moore Inc, Bridgeport, Conn.
Jas P Marsh Corp, Chicago
Wm W Nugent & Co Inc, Chicago
Sarco Co, New York
Schutte & Koerting Co, Philadelphia
Staynew Filter Corp, Rochester, N. Y.
Strong, Carlisle & Hammond Co, Cleveland
Swartwout Co, Cleveland
Watts Regulator Co, Lawrence, Mass.
Wright-Austin Co, Detroit

STROBOSCOPES

General Radio Co, Cambridge, Mass.
Westinghouse Electric & Mfg Co, East Pittsburgh

SWITCHES & SWITCHBOARDS

Allis-Chalmers Mfg Co, Milwaukee
Allen-Bradley Co, Milwaukee
Automatic Switch Co, New York
Burgess Battery Co, Madison, Wis.
Bromfield Mfg Co, Inc, Boston
Bryant Electric Co, Bridgeport, Conn.
Bull-Dog Electric Products Co, Detroit
Columbia Electric Mfg Co, Cleveland
Commonwealth Electric Co, St. Paul, Minn.
Cutler-Hammer Inc, Milwaukee
Delco-Remy Corp, Anderson, Ind.
General Electric Co, Schenectady, N. Y.
Ideal Electric & Mfg Co, Mansfield, Ohio
I-T-E Circuit Breaker Co, Phila.
Lexington Electric Products Co, N. Y.
Monitor Controller Co, Baltimore, Md.
Penn Electric Switch Co, Goshen, Ind.
Roller-Smith Co, New York
Sundh Electric Co, Cleveland
Square-D Co, Detroit
Standard Switchboard Co, Brooklyn, N. Y.
Trumbull Electric Mfg Co, Plainville, Conn.
Westinghouse Electric & Mfg Co, East Pittsburgh
Wheelco Instruments Co, Chicago
Wm Wurdack Electric Mfg Co, St. Louis
Woolfe & Mann Mfg Co, Baltimore

TACHOMETERS

(See also Indicators, Speed)
Electric Tachometer Corp, Phila.
Barbour Stockwell Co, Cambridge, Mass. (Hand, centrifugal)
Herman H Sticht & Co, New York

TANKS, AIR

Alco Products Inc, New York
Allis-Chalmers Mfg Co, Milwaukee
Beach-Russ Co, New York
Bigelow Co, New Haven, Conn.
Chicago Bridge & Iron Co, Chicago
Chicago Pneumatic Tool Co, New York
Combustion Engrg Co Inc, New York
Edge Moor Iron Works Inc, New York
Graver Tank & Mfg Co, East Chicago, Ind.
Ingersoll-Rand Co, New York
M W Kellogg Co, Jersey City, N. J.
Murray Iron Works Co, Burlington, Ia.
Pangborn Corp, Hagerstown, Md.
Pressed Steel Tank Co, Milwaukee
A O Smith Corp, Milwaukee
Westinghouse Air Brake Co, Wilmerding, Pa.
Worthington Pump & Machinery Corp, Harrison, N. J.
Sullivan Machinery Co, Michigan City, Ind.

TANKS, STORAGE

Alberger Heater Co, Buffalo, N. Y.
Allis-Chalmers Mfg Co, Milwaukee
Alpha Tank & Sheet Metal Co, St. Louis
Anthony Co, Long Island City, N. Y.
Babcock & Wilcox Co, New York
Bartlett Hayward Div, Baltimore, Md.
Bigelow Co, New Haven, Conn.
S F Bowser & Co Inc, Fort Wayne, Ind.
Blaw-Knox Co, Pittsburgh
W E Caldwell Co Inc, Louisville, Ky.
Chicago Bridge & Iron Co, Chicago
Combustion Engrg Co Inc, New York
Connery Construction Co, Phila.
Downington Iron Works, Downington, Pa.
Edge Moor Iron Works Inc, New York
Erie City Iron Works, Erie City, Pa.
Gifford-Wood Co, Hudson, N. Y.
Graver Tank & Mfg Co, E. Chicago, Ind.
Jones & Laughlin Steel Corp, Pittsburgh
E Keeler Co, Williamsport, Pa.
Kroeschel Boiler Co, Racine, Wis.
Quaker City Iron Works, Philadelphia
Lukens Steel Co, Coatesville, Pa.
Murray Iron Works Co, Burlington, Ia.
National Tube Co, Pittsburgh
Pittsburgh-Des Moines Steel Co, Pittsburgh
Wm B Scaife & Sons Co, Oakmont, Pa.
Stover Steel Tank & Mfg Co, Freeport, Ill.
Titusville Iron Works Co, Titusville, Pa.
Union Boiler & Mfg Co, Lebanon, Pa.
Henry Vogt Machine Co, Louisville, Ky.
Wickes Boiler Co, Saginaw, Mich.
Williamette Iron & Steel Corp, Portland, Ore.
Youngstown Steel Tank Co, Youngstown, Ohio

THERMOCOUPLES

Bailey Meter Co, Cleveland
Bristol Co, Waterbury, Conn.
Brown Instrument Co, Philadelphia
Foxboro Co, Foxboro, Mass.
General Electric Co, Schenectady, N. Y.
Illinois Testing Labs Inc, Chicago
Leeds & Northrup Co, Philadelphia
Republic Flow Meters Co, Chicago
C J Tagliabue Mfg. Co, Brooklyn
Taylor Instrument Cos, Rochester, N. Y.
Roller-Smith Co, New York
Thwing-Albert Instrument Co, Phila.
Westinghouse Electric & Mfg Co, East Pittsburgh
Wheelco Instruments Co, Chicago

THERMOMETERS

American Temperature Indicating Co, Toledo, Ohio
Bailey Meter Co, Cleveland
Bristol Co, Waterbury, Conn.
Brown Instrument Co, Philadelphia
Defender Automatic Regulator Co, St. Louis
Diesel Plant Specialties Co, Chicago
Electric Auto-Lite Co, New York
Chas Engelhard Inc, Newark, N. J.
Foxboro Co, Foxboro, Mass.
Julien P Friez & Sons Inc, Baltimore
King-Seeley Corp, Ann Arbor, Mich.
Lewis Engrg Co, Naugatuck, Conn.
Leeds & Northrup Co, Philadelphia
Liquidometer Corp, Long Island City, N. Y.
Manning, Maxwell & Moore, Inc, Bridgeport, Conn.
Minneapolis-Honeywell Regulator Co, Minneapolis, Minn.
Illinois Testing Labs Inc, Chicago
Moeller Instrument Co, Richmond Hill, N. Y.
Precision Thermometer & Instrument Co, Philadelphia
Powers Regulator Co, Chicago
Republic Flow Meters Co, Chicago
Rochester Mfg Co, Rochester, N. Y.
Sarco Co, New York
Standard Thermometer Inc, Boston
C J Tagliabue Mfg Co, Brooklyn, N. Y.
Taylor Instrument Cos, Rochester, N. Y.
Thwing-Albert Instrument Co, Phila.
Uehling Instrument Co, Paterson, N. J.
U S Gage Co, New York
Viking Instruments Inc, New York
Carl H Wagner & Son, Chicago
Weston Electric Instrument Co, Newark, N. J.
Wheelco Instruments Co, Chicago

TOOLS, CYLINDER HONING

Barnes Drill Co, Rockford, Ill.
Carborundum Co, Hutto Machine Div, Detroit
Micromatic Hone Corp, Detroit
Simplicity Mfg Co, Port Washington, Wis.

TOOLS, VALVE REGRINDING

Hall Mfg Co, Toledo, Ohio
Hutton & Jenks, Bancroft, Iowa
Leavitt Machine Co, Orange, Mass.
M B Skinner Co, South Bend, Ind.
United States Electrical Tool Co, Cincinnati

TRANSMISSION

(See Belting, Chain, Clutches, Couplings, Gearing)

VALVES, COMPRESSOR

Binks Mfg Co, Chicago
Cooper-Bessemer Corp, Mt. Vernon, O.
Crane Co, Chicago
Jenkins Bros, New York
J H H Voss Inc, New York
Worthington Pump & Machinery Corp, Harrison, N. J.

VALVES, GATE, GLOBE, CHECK

V D Anderson Co, Cleveland
Barrett Haentjens & Co, Hazelton, Pa.
H Belfield Co, Philadelphia
Bridgeport Brass Co, Bridgeport, Conn.
Chapman Valve Mfg Co, Indian Orchard, Mass.
Crane Co, Chicago
Darling Valve & Mfg Co, Williamsport, Pa.
Edward Valve & Mfg Co, E. Chicago, Ind.
Everlasting Valve Co, Jersey City, N. J.
Fairbanks Co, New York
Grinnell Co, Providence, R. I.
Homestead Valve Mfg Co, Coraopolis, Pa.
Jarecki Mfg Co, Erie, Pa.
Jenkins Bros, New York
Kennedy Valve Mfg Co, Elmira, N. Y.
Ludlow Valve Mfg Co, Troy, N. Y.
Lunkenheimer Co, Cincinnati
Manistee Iron Works, Manistee, Mich.
Manning, Maxwell & Moore Inc, Bridgeport, Conn.
Parker Appliance Co, Cleveland
Pittsburgh Valve & Fittings Corp, Barberton, Ohio
Wm Powell Co, Cincinnati
Reading-Pratt & Cady Div, Bridgeport, Conn.
W S Rockwell Co, New York
Ross Valve Co, Troy, N. Y.
Schutte & Koerting Co, Philadelphia
John Simmons Co, Long Island City, N. Y.
Strong Carlisle & Hammond Co, Cleveland
Taylor Forge & Pipe Works, Chicago
Henry Vogt Machine Co, Louisville
Walworth Co, New York
D T Williams Valve Co, Cincinnati
Yarnall-Waring Co, Philadelphia

VALVES, RELIEF

Ashton Valve Co, Cambridge, Mass.
A W Cash Co, Decatur, Ill.
Crane Co, Chicago
Crosby Steam Gage & Valve Co, Boston
Davis Regulator Co, Chicago
Edward Valve & Mfg Co, E. Chicago, Ind.
Fisher Governor Co, Marshalltown, Ia.
Foster Engrg Co, Newark, N. J.
Kieley & Mueller Inc, New York
Jenkins Bros, New York
J E Lonergan Co, Philadelphia
Ludlow Valve Mfg Co, Troy, N. Y.
Lunkenheimer Co, Cincinnati
Manning, Maxwell & Moore Inc, Bridgeport, Conn.
Mason-Neilan Regulator Co, Boston
Mercon Regulator Co, Milwaukee
Wm Powell Co, Cincinnati
Swartwout Co, Cleveland

VALVES, REGULATING

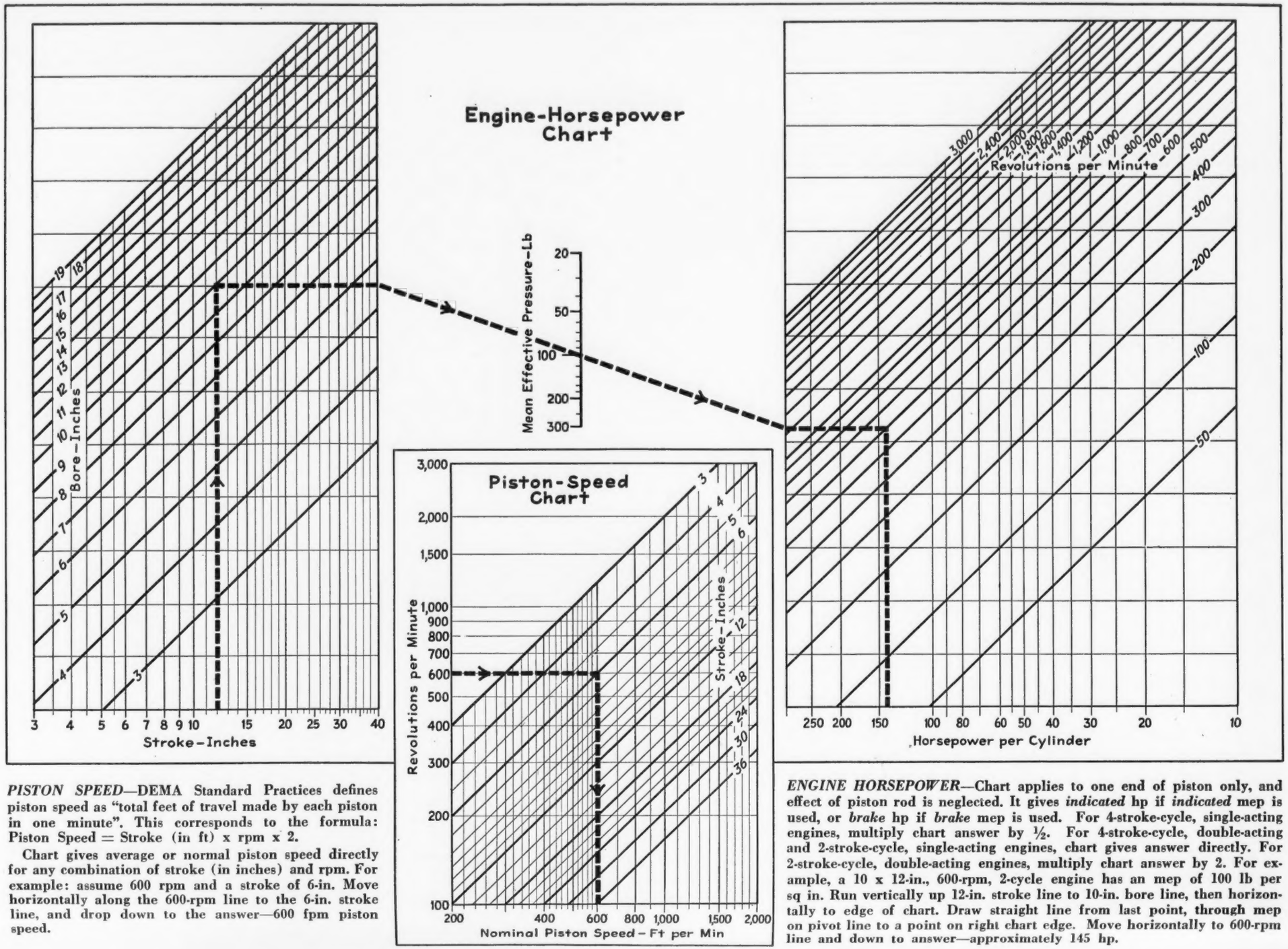
Atlas Valve Co, Newark, N. J.
Atwood & Morrill Co, Salem, Mass.
Bailey Meter Co, Cleveland
H Belfield Co, Philadelphia
Bristol Co, Waterbury, Conn.
A W Cash Co, Decatur, Ill.
Chaplin-Fulton Mfg Co, Pittsburgh
Davis Regulator Co, Chicago
Fisher Governor Co, Marshalltown, Ia.
Foster Engrg Co, Newark, N. J.
Kieley & Mueller Inc, New York
Manning, Maxwell & Moore Inc, Bridgeport, Conn.
Mason-Neilan Regulator Co, Boston
Mercoid Corp, Chicago
Mercon Regulator Co, Milwaukee
Minneapolis-Honeywell Regulator Co, Minneapolis, Minn.
Northern Equipment Co, Erie, Pa.
Penn Electric Switch Co, Goshen, Ind.
Ruggles-Klingemann Mfg Co, Salem, Mass.
C E Squires Co, Cleveland
Republic Flow Meters Co, Chicago
Spence Engrg Co Inc, Walden, N. Y.
Strong, Carlisle & Hammond Co, Cleveland
Swartwout Co, Cleveland
Taylor Instrument Cos, Rochester, N. Y.

VIBRATION ISOLATION

Armstrong Cork Products Co, Lancaster, Pa.
Cork Insulation Co, New York
Keldur Corp, New York
Korfund Co, Long Island City, N. Y.
Manhattan Rubber Mfg Div, Passaic, N. J.
Mundet Cork Corp, New York
United Cork Cos, Kearney, N. J.
U S Gypsum Co, Chicago
U S Metal Hose Co Inc, New York
Vibration Elimination Co, Long Island City, N. Y.

VIBROMETERS

American Askania Corp, Dallas, Tex.
James G Biddle Co, Philadelphia
Electrocon Corp, New York
General Radio Co, Cambridge, Mass.
L S Starrett Co, Athol, Mass.
Westinghouse Electric & Mfg Co, East Pittsburgh



PISTON SPEED—DEMA Standard Practices defines piston speed as "total feet of travel made by each piston in one minute". This corresponds to the formula: Piston Speed = Stroke (in ft) x rpm x 2.

Chart gives average or normal piston speed directly for any combination of stroke (in inches) and rpm. For example: assume 600 rpm and a stroke of 6-in. Move horizontally along the 600-rpm line to the 6-in. stroke line, and drop down to the answer—600 fpm piston speed.

ENGINE HORSEPOWER—Chart applies to one end of piston only, and effect of piston rod is neglected. It gives *indicated* hp if *indicated* mep is used, or *brake* hp if *brake* mep is used. For 4-stroke-cycle, single-acting engines, multiply chart answer by ½. For 4-stroke-cycle, double-acting and 2-stroke-cycle, single-acting engines, chart gives answer directly. For 2-stroke-cycle, double-acting engines, multiply chart answer by 2. For example, a 10 x 12-in., 600-rpm, 2-cycle engine has an mep of 100 lb per sq in. Run vertically up 12-in. stroke line to 10-in. bore line, then horizontally to edge of chart. Draw straight line from last point, through mep on pivot line to a point on right chart edge. Move horizontally to 600-rpm line and down to answer—approximately 145 hp.

Engineer Jones Goes to the Fair

Chief Bill Jones went to the New York World's Fair on opening day, April 30. We spotted him as he went through the turnstiles, and asked to tag along with a camera. Here's a picture record of Engineer Jones' trip through the brave new world in Flushing Meadows

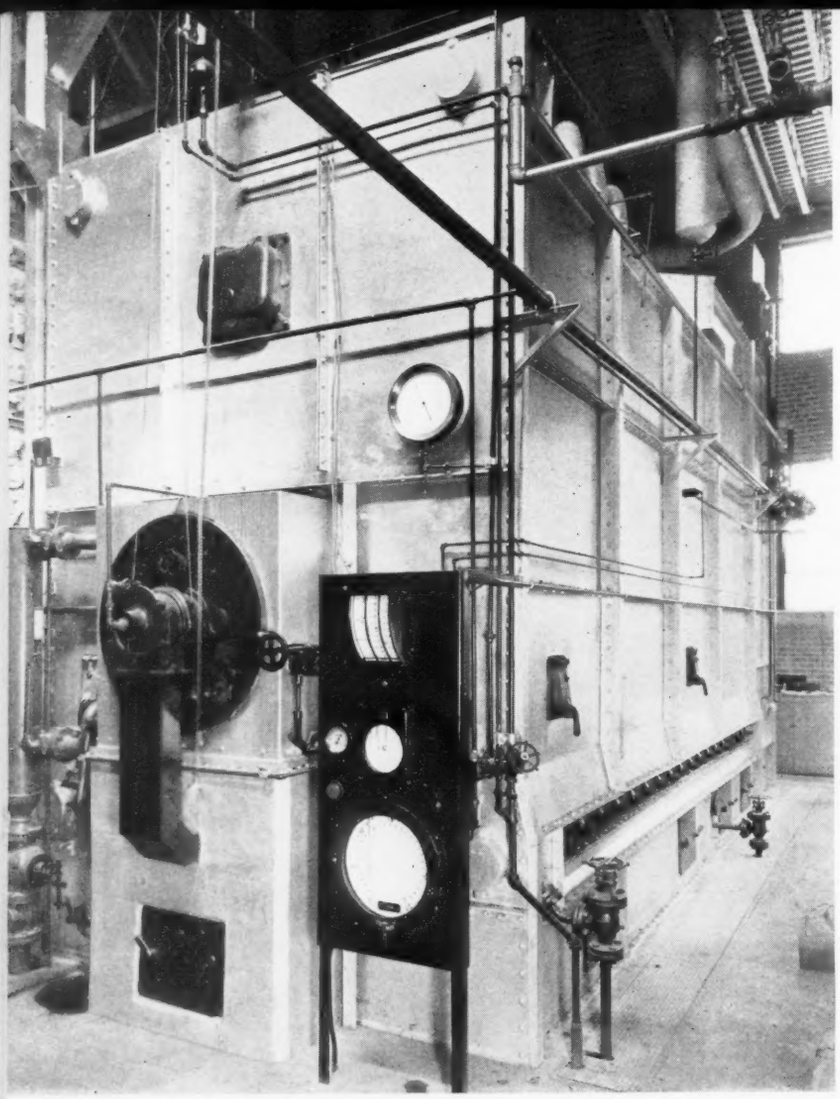
1 *"Steam, water, wires, gears—that sure spells power," says Engineer Jones, gazing at the Utilities Building*

2 *"Big switch, b'gosh! Wonder who thought that up"*

3 *"I don't mind being televised by GE, but I'm not used to the spotlight. Make it snappy or I'll get sunburned"*

4 *Meanwhile Power's photo-man sneaks a snap of Jones' face in the television receiver 60 ft away*

continued on page 88



RILEY "RO" GAS FIRED BOILER UNIT
Rochester Dairy Co., Rochester, Minn.

a dollars and cents study shows why it

Actual results in the field prove efficiencies from Riley "RO" Units are normally five per cent higher than efficiencies from ordinary brick set boilers. This is easily accounted for by lower flue gas temperatures resulting from the use of the integral economizer with Riley "RO" Boilers, by less radiation loss because of the use of water-cooled furnace with steel-clad insulated setting and by higher combustion efficiency made possible because of the water-cooled furnace.

If you are producing 20,000 pounds of steam per hour, 10 hours a day, and 300 days a year, and coal costs $5.00 per ton delivered, coal costs with a Riley "RO" Unit would be $13,200.00 annually. Coal cost with a unit operating at 5% lower efficiency would be $14,080.00. The "RO" Unit would save $880.00 each year in coal costs alone. There would also be large savings in maintenance, especially furnace brick-work maintenance, because with the Riley "RO" Boiler, water walls protect the furnace refractories.

Let's see how much less you must pay for an ordinary brick set job in order to make purchase of such old-fashioned equipment businesslike. Your annual coal saving with an "RO" Boiler is $880.00. In five years this saving amounts to $4,400.00. Isn't it correct in assuming therefore that you must pay at least $4,400.00 less for an ordinary job to produce 20,000 pounds of steam per hour than you would for a Riley "RO" Unit of the same size. But a Riley "RO" Unit will not cost nearly that much more. Do you not agree that a dollars and cents study shows it pays to install Riley "RO" Boilers.

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It will pay you to visit modern Riley Installations

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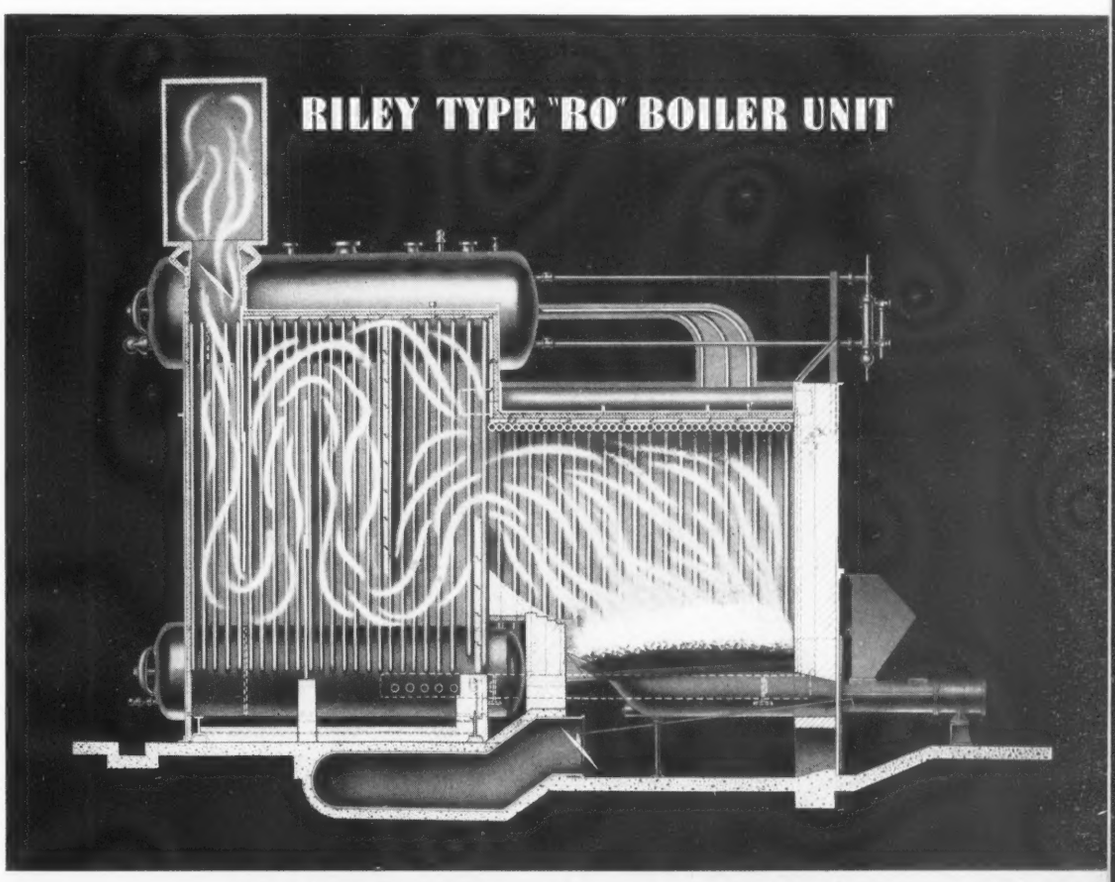
Pet Milk Co. ..... Delta, Ohio
Pet Milk Co. ..... Weyland, Mich.
Pet Milk Co. ..... Neosho, Mo.
Hercules Powder Co. .... Carthage, Mo.
Nunn Bush Shoe Co. . Milwaukee, Wis.
Seeger Refrigerating Co. St. Paul, Minn.
Bastian Bros. ..... Rochester, N. Y.
Chestnut Farms Dairy Washington, D. C.
Crescent Puritan Laundry Rochester, N. Y.
Rochester Dairy Co. . Rochester, Minn.
Worcester Academy . . Worcester, Mass.
Seneca Knitting Co. Seneca Falls, N. Y.
Pratt, Read Co. ..... Ivoryton, Conn.
Hooker Paint & Glass Co. Chicago, Ill.
Francis Shimer School Mt. Carroll, Ill.
Armour & Co. ..... Baltimore. Md.



For Capacities between 7,500 and 40,000 lbs. per hour
THE RILEY TYPE "RO" STEAM GENERATING UNIT

RILEY "RO" BOILERS SAVE MONEY—*because of*

higher possible combustion efficiency
lower flue gas temperatures
less radiation loss
lower maintenance

A survey of your power plant by a consulting engineer will possibly show ways of making surprisingly large savings in power costs

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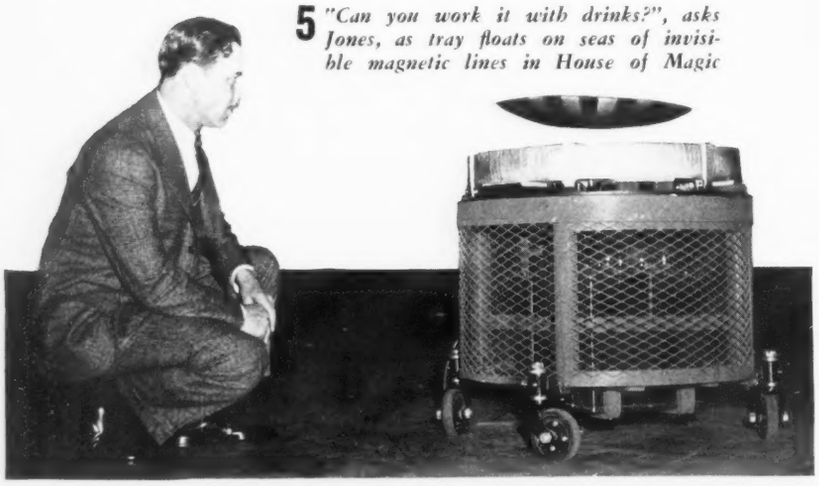
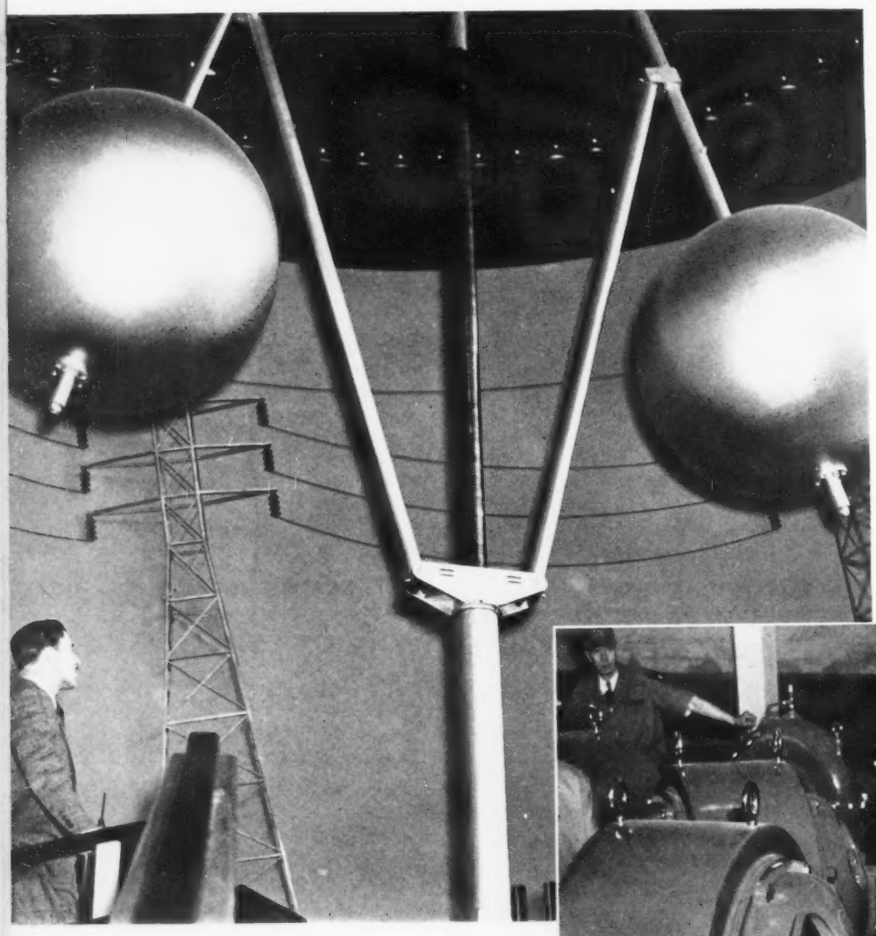
before purchasing Boiler or Fuel Burning Equipment

Engineer Jones Goes to the Fair—Continued from page 85

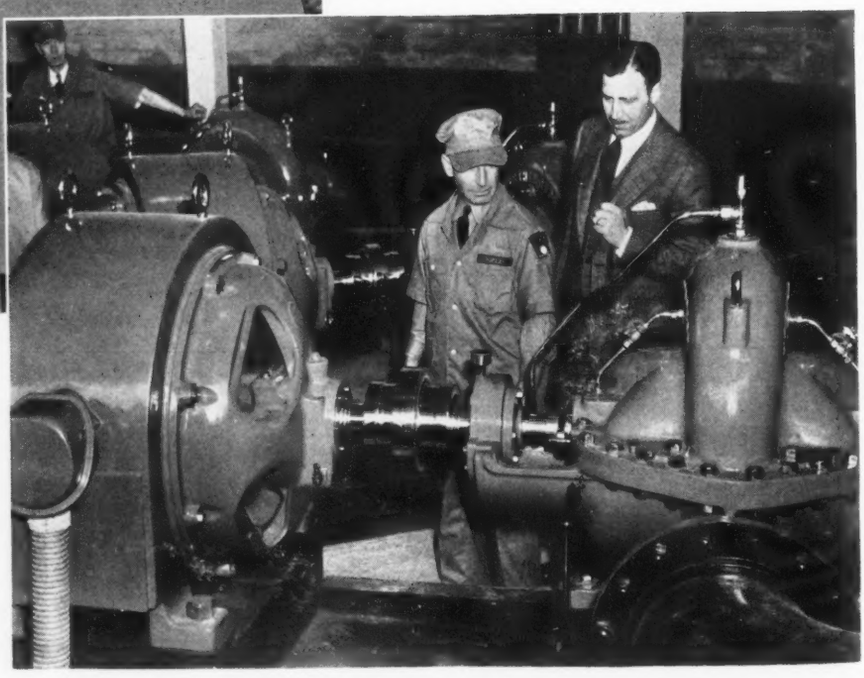


5 *"Can you work it with drinks?", asks Jones, as tray floats on seas of invisible magnetic lines in House of Magic*

6 *So they take him away to Steinmetz Hall to see a 10,000,000-volt lightning bolt 30 ft long and gaze at this sizzling discharge*



7 *"I understand the principle, but if this is a sample of Watt's governor, please bring on the engine, Mr. Westinghouse"*



8 *"Eleven Worthington pumps driven by Westinghouse motors—2700 hp in all. No wonder that fountain in the Lagoon of Nations looks like Niagara upside down*

28 Answers to Your Dust-Collection Problem

1

It's the same nuisance whether from stoker cinder or pulverized-coal flyash, but equipment varies widely. Shall it be filter, scrubber, fan, cyclone or electrostatic precipitator?

By R T ROBERTS, *Asst Division Engineer*
Consolidated Edison Co of New York, Inc

FLYASH AND CINDER elimination is becoming increasingly important, due to increased stress on the subject by civic organizations, new codes being enacted and the more active attitude on the part of City officials.

Public utilities are often mistakenly regarded as principal transgressors. The error of this attitude in New York City can quickly be discovered by a look at the curves of dust concentration in the City atmosphere released by David Morris of the Meteorological Observatory in Central Park. These curves show a rather low constant dust content through the summer months, and a heavy increase through the fall, winter and spring months. This increase is principally due to household and other heating systems, while the summer curve more nearly portrays normal dust and the products of industrial and utility operation.

The purpose here is to describe and trace the development of equipment available for dust and cinder abatement from the point of view of power-plant operation. Industrial processes have a special problem not within the scope of this description. Smoke is also not considered, as smoke elimination can better be accomplished by construction changes and operating procedure.

In power-plant operation, with the exception of coal-dust reclamation, dust collectors are used to catch a product of no great use. Therefore, the cost, operation and maintenance of equipment can be charged only to public relations and good will, and can only be so justified. This limits the designer's choice to equipment that will serve the purpose, with low first and operating costs, and a minimum of maintenance.

Many conflicting claims have arisen among manufacturers of different types of collectors. Some claim that by removing the larger particles, with a lower over-all efficiency they remove the material which falls within the nuisance range, or the material which falls in the vicinity of the plant. Others strive for high over-all efficiency.

The answer is that nuisance range is a rather indefinite term. What would be nuisance range in a large city is far different from what would be considered nuisance in a small town, or even in another large city with different character of neighborhood.

A clean stack is a visible advantage and should be sought, bearing in mind that larger particles falling in the plant vicinity can sometimes offset this advantage. There is no royal road to cinder-catcher selection.

Filters

Filters have not been used for elimination of dust from boiler flue gas, because to date they have not been built to stand temperatures in excess of approximately 250 F. Cotton as a filtering medium will stand about 150 F, while wool can be used up to 250 F.

While filters are among the most efficient cleaners, the temperature limitation has previously restricted their use to cleaning air where no great amount of moisture is present, such as mill and bin vents, transport air in pneumatic handling systems or to the air for ventilation.

However, the glass industry has recently developed a glass cloth which in the near future may bring this type of equipment into the field of boiler-gas cleaning. The softening temperature is above 1100 F, and the working temperature can be as high as 900 F without damage. The cloth is rather hard in its weave compared to earlier materials and not so thick, resulting in a filter medium claimed not to wear or abrade during the shaking period.

There are two general classes of filters. Bag filters usually consist of a conical hopper above which is mounted a dividing sheet, through which are holes the approximate size of each filter bag. Filter bags are hung by the closed end from a head frame with the open end fastened over the hole in the dividing sheet.

Gas to be cleaned is admitted below the dividing sheet and filters through the cloth, clean gas being discharged from the housing around the bags. As dust builds up on the bags, it is loosened by agitating the head frame mechanically or pneumatically, at the same time closing off the filter and admitting compressed air to the housing. Where the filter is under vacuum, the vacuum can be broken and atmospheric air admitted to the bag housing. This air, either compressed or atmospheric, passes through the filter in the reverse direction and cleans the cloth, depositing the dust in the conical hopper. Fig. 1 shows a common type.

Flat filters usually consist of frames on which the filter medium is stretched. Frames are nested to provide maximum filter area in minimum space, and air is admitted to the housing on one side of the filter and discharged from the housing on the other side. Rappers vibrate the frames for filter cleaning and dust drops to a hopper below the frames. Reverse air flow can be used if necessary. Fig. 2 shows one type.

Cleaning of the filtering medium may be on a fixed time cycle or by differential pressure, as desired. Protection against filter breakage may be attained by a differential-pressure switch, across inlet and discharge side of filter medium, so that shaking

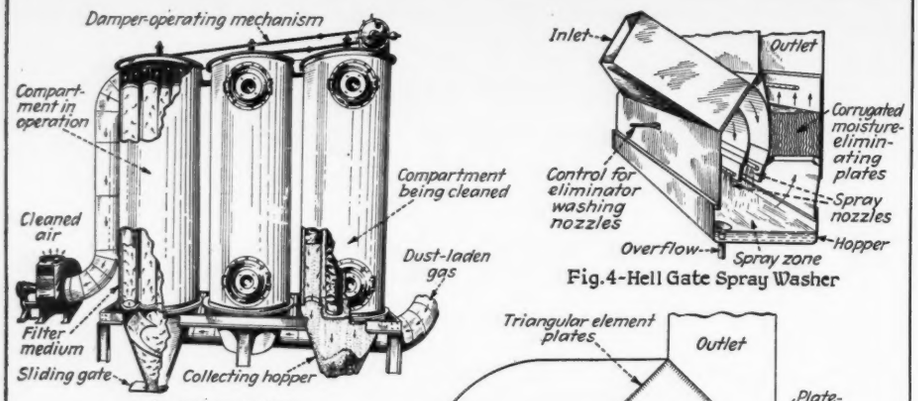


Fig.1-Bag Filter

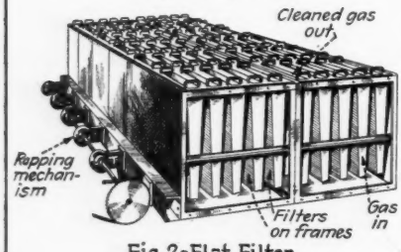


Fig.2-Flat Filter

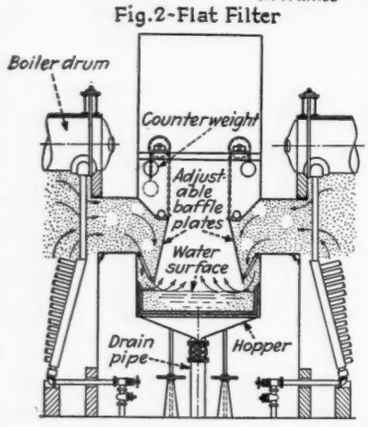


Fig.3-Murray Washer-Serving Two Boilers

Fig.4-Hell Gate Spray Washer

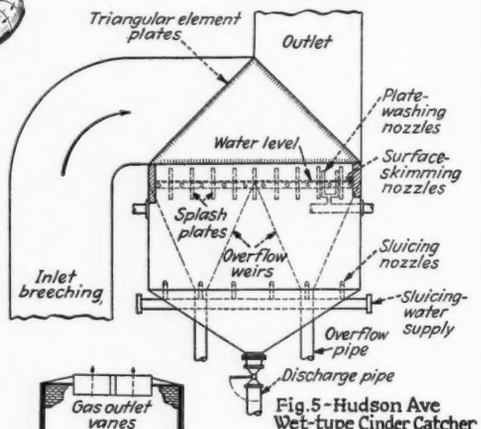


Fig.5-Hudson Ave Wet-type Cinder Catcher

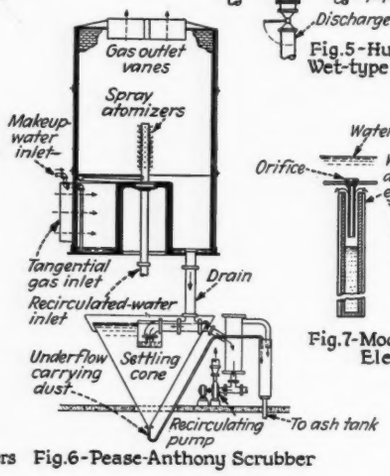


Fig.6-Pease-Anthony Scrubber

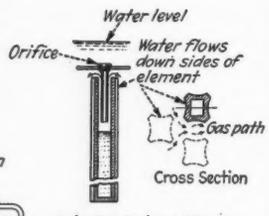


Fig.7-Modave Washer Element

or shutdown occurs at max. pressure.

Well designed filters have efficiencies up to 99.9% and require from ¾ in. to 2 in. draft loss, but occupy more space than other types of cleaning apparatus. The main item of maintenance is the filter bags.

Washers as a class, where well designed, show high efficiency, and can usually be relied on to give 90% and above, at draft losses from ¾ in. to 1½ in. They require smaller space than other types, but must be made corrosion resistant for low maintenance. They may require large quantities of water, depending on design.

Washer design should eliminate moisture and sludge carryover, as beyond the washer, corrosion attacks flues and stack, or sludge may unbalance fans or form in dangerous amounts on flue walls.

Washers also necessitate wet handling of sludge, a settling pit and crane or similar arrangement, except where sludge can be run off to a vacant area.

Probably more washer designs have been made than any other type of cleaning equipment. In the Consolidated Edison System, the most successful of the early washers for stoker cinder was the Murray washer, probably the beginning of the art.

In Fig. 3 is shown one of the early types at Waterside Station. It consisted of a wetted baffle which turned the gas at right angles under the baffle and over a body of water. Contact with the baffle and change in direction forced the cinders into the water bath. The baffle was adjustable to minimize draft loss at high load, but efficiency dropped off as load increased. The average efficiency at moderate load was about 80%.

As the trend toward pulverized fuel increased, many washers were developed and tested at Sherman Creek Station of the old United Electric Light and Power Co. A dozen ideas were developed, but soon dropped because of low efficiency and high draft loss.

These experiments did, however, lead to a later type of spray-zone washer for flyash, built at Hell Gate. The old Murray baffle and water pan were retained, but a row of spray nozzles at the washer inlet filled the entire zone with a fine mist. The dust particles were thoroughly wetted before passing under the baffle, and were thrown out. In the outlet, a series of corrugated plates eliminated carryover sludge and water to a great extent, but rapidly plugged, causing draft-loss increase. To overcome this, a reciprocating plate washer was developed consisting of an upright pipe or manifold on which were mounted nozzles to throw a solid stream lengthwise of the corrugations. This kept draft loss within a reasonable range. Fig. 4 shows arrangement.

Hudson Ave Catcher

Almost simultaneously, another washer was built at Hudson Avenue Station for stoker cinders. Fig. 5 shows details of an inlet and outlet, so arranged over the water bath that the gas is split into a multiplicity of thin streams. Alternate spaces are inlets and outlets, so that the entering gas passes under the edges of each space to the outlet. Inlets are narrower than outlets, causing a change in velocity as well as direction over the water bath. Advantages are lower draft loss and higher efficiency than the Murray washer. By dividing the gas stream into thin layers, it is easier to throw the dust particles across the stream, and 85% efficiency with a ¾-in. draft loss is attained. As protection against corrosion, the elements are enamelled; splash plates are of extruded carbon.

Pease Anthony Scrubbers have been used by Boston Edison Company for some years. As originally built, these consisted of a circular chamber about 12 ft in diameter by 16 ft high with rotating-disc atomizers. The gases entered at the bottom tangentially and were sprayed with water during their passage through the chamber. Later revisions employ a vertical pipe equipped with stationary atomizing nozzles for dust wetting.

Below the washer is a Callow cone in which sludge is settled and removed by underflow from the cone. The water is recirculated, Fig. 6.

Reported efficiency is 95% with 1¼-in. draft loss, and that all SO_3 and 3 to 4% of SO_2 is removed. For 600,000 lb of gas per hour, water consumption is 300 gpm at 40-ft head.

The Modave washer is extensively used in France, Germany, Italy and England. As shown in Fig. 7, it consists of square, hollow, vertical tubes,

with concave sides, set in staggered arrangement in the gas flow. Water from an overhead tank overflows the top of the tube and forms a film of water down the sides. Cinders are thrown against the film and carried to the hopper below. Reports give 92 to 97% efficiency and 70% removal of sulphur acids with 3 to 4 gal. of water per thousand cu ft of gas. Temperature drops 125 F. This washer design was brought to America and variations made in which plates were substituted for the concave-sided tubes used in Europe. See Fig. 8.

The Pfleiderer Washer, another European development, is shown in Fig. 9. It consists of a circular chamber disposed horizontally, into which gas enters tangentially and is sprayed during passage. The last section of the washer splits the gas into small streams, walls and baffles being wetted to act as eliminators. Many materials have been employed to resist abrasion and corrosion, the last reported being hard rubber. Reports give better than 90% efficiency.

An American washer, somewhat similar in principle is now offered for installation at the base of the stack. First applications, however, were at the top of the stack and consisted of a hood shown in Fig. 10. The gas passed under the hood and was wetted by spray from two rings of nozzles. Reports have been made of 90% efficiency with one gal. water per 700 cfm.

Much has been written about the installation at Battersea, shown in Fig. 11. This installation consists of a flue into which gas is admitted and wetted in the presence of iron to help in the conversion of SO_2 to SO_3. The gas then passes to a tower where it is scrubbed and sprayed with alkaline water to eliminate sulphur.

This washer is a chemical plant in itself, and it suffices to say that nowhere in this country could it be found adaptable to power-plant use. A power plant requiring such an elaborate arrangement would necessarily be in a large city, where land cost would be exorbitant, practically doubling the ground area of the plant. Likewise, using twenty tons of water per ton of coal would be a serious operating and maintenance charge. Gas cleaning costs given for Battersea and similar installations reflect these charges. Battersea: 33 to 36 cents per net ton of coal; Fulham: $1.15 per net ton; Swansea is reported to have had plugging difficulties which will probably require revisions.

Froth flotation washers were originally developed to clean gas from an enamelling plant. The first installation was so successful that about ten were finally installed in this plant.

As originally designed, gas was admitted to a lower spray chamber and passed upward through holes in the top of the chamber. Inverted over each hole was a circular cap, with the edge submerged in water to which had been added the frothing oil. After the gas passed under the inverted cap and through the froth bath, it was led to an upper chamber through impingers for drying. This is shown in Fig. 12.

For power plants, one type of this washer is shown in Fig. 13. It consists substantially of a primary chamber where the gas is sprayed with an oil-and-water mixture formed by drums which rotate partially submerged in the tank at the bottom. From the primary chamber, the gas is passed through bubble caps to the outlet. In others, spray chambers and eliminators alternately wet and dry the gas.

[Editor's Note: Part II of this article, dealing with centrifugal and electrostatic collectors, will appear in July.]

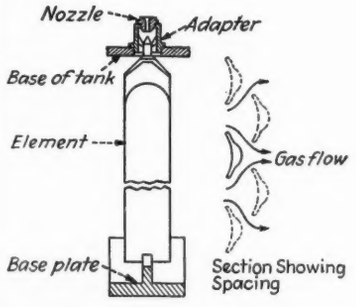


Fig.8-American Modave Washer Element

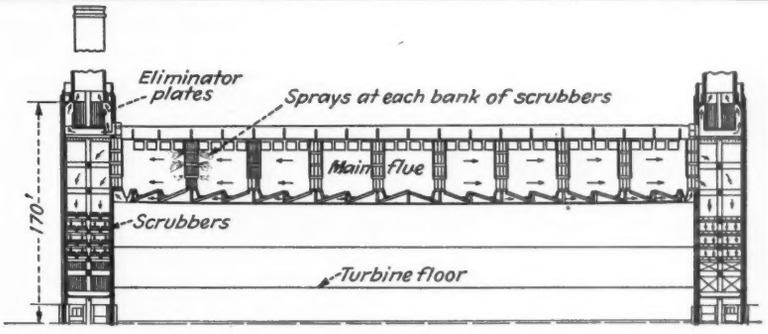


Fig.11-Battersea Flue-gas Treatment Plant

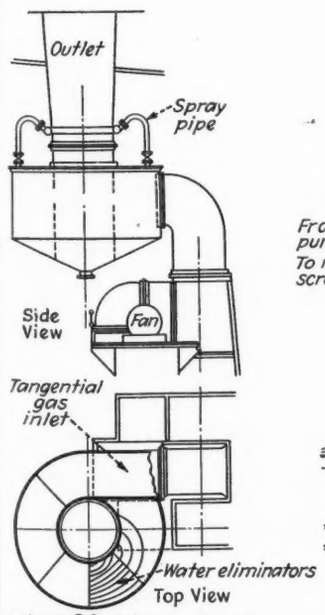


Fig.9-Pfleiderer Washer

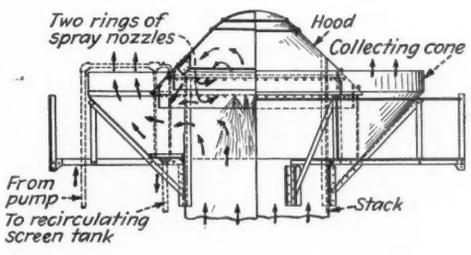


Fig.10-Spray Hood at Top of Stack

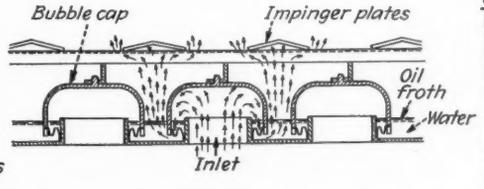


Fig.12-Froth Flotation Washer

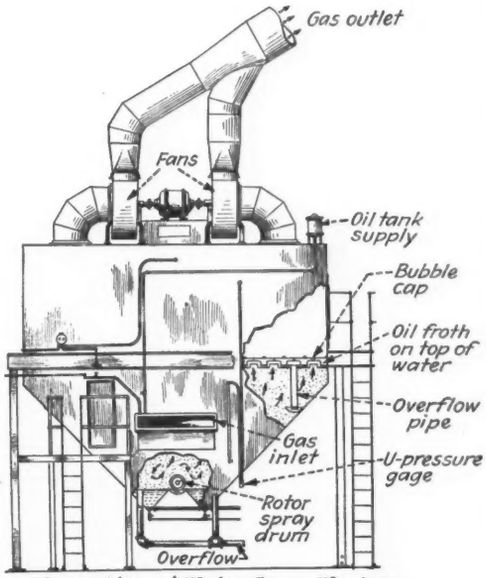


Fig.13-Oil and Water Spray Washer

Keep the Pump–Change the Pipe

Tests show that in many cases, added pump capacity can be most economically obtained by increasing pipe size instead of by junking the old pump

By FRANK A KRISTAL

WHEN CAPACITY and pressure of pumping installations drop off, the reason is usually said to be internal wear of the pump. However, a frequent cause of this reduction may be internal condition of the pipeline. An interesting case in point occurred recently where increased water capacity was required.

In this installation, pump suction was from a large river near the plant, where water level was fairly constant. The pump discharged into a 50,000-gal. tank above the plant. When originally purchased, the pump had a capacity of 1000 gpm against 110-ft total dynamic head, as shown in Fig. 1, and was driven by a 50-hp, 1750-rpm motor.

Because of gradual expansion, water demand increased so much that the pump could not keep up. A fairly accurate test of the pump was made by checking flow into the tank for a stated period of time. From this test, it was determined that the pump was delivering 650 gpm against 115-ft total dynamic head. Before making the test, the pump had been fitted with new wearing rings, shaft sleeves and new packing so that the test would give an accurate indication of what the pump could do in good condition.

The test showed that total dynamic head included 35-ft static head plus the head due to friction in the following piping and fittings:

	Equivalent feet of pipe
In the suction line:	
10 ft of 8-in. straight pipe	10
One 8-in. elbow	24
One foot valve and strainer	110
In the discharge line:	
2060 ft of 8-in. straight pipe	2060
Six 8-in. elbows	144
One 8-in. check valve	110
One 8-in. gate valve	12

The total was equivalent to 2470 ft of straight pipe to be considered in figuring friction. With 1000 gpm flowing in the pipe for which the pump was originally installed, a friction head of 75 ft occurred. This added to the total static head of 35 ft made a total dynamic head of 110 ft, which checked with the conditions shown by the pump characteristic curve, Fig. 1.

In the test, total dynamic head was 115 ft, which showed that the friction head amounted to 115 − 35 = 80 ft, with 650 gpm flowing through the line. Referring to a set of head-loss-due-to-friction tables, we found that with 650 gpm flowing in 8-in. pipe, head-loss due to friction was 1.34 ft per 100 ft of pipe. Therefore, the 80-ft of friction head found in the test indicated a pipe length of (80 × 100) ÷ 1.34 = 6000 ft approximately, instead of the 2470 ft estimated. Apparently corrosion had reduced pipe inside diameter.

In planning for installation of a new pump to deliver 1000 gpm through the old pipe, estimates were made on the basis of an equivalent 6000 ft of 8-in. pipe, which showed that the pump would have to operate against a total dynamic head of 216 ft.

Because of the excessive power, 75 hp, required for this pump, consideration was given to replacing the old pipe. Studies, made to decide upon the size of pipe, developed the curves, Fig. 2. With the old pipe, the old pump would deliver 650 gpm against a head of 118 ft (point *A*), and the proposed new pump, 1000 gpm against a head of 216 ft, (point *B*), as previously indicated. If new 8-in. pipe were installed, the old pump would deliver 1000 gpm against a total head of 110 ft, (point *C*), and the new pump 1400 gpm at 170-ft head (point *D*).

By installing 10-in. pipe, the head at 1450 gpm dropped to about 82 ft (point *E*), a condition that could be met with the old pump. When this pipe was installed the pump delivered plenty of water.

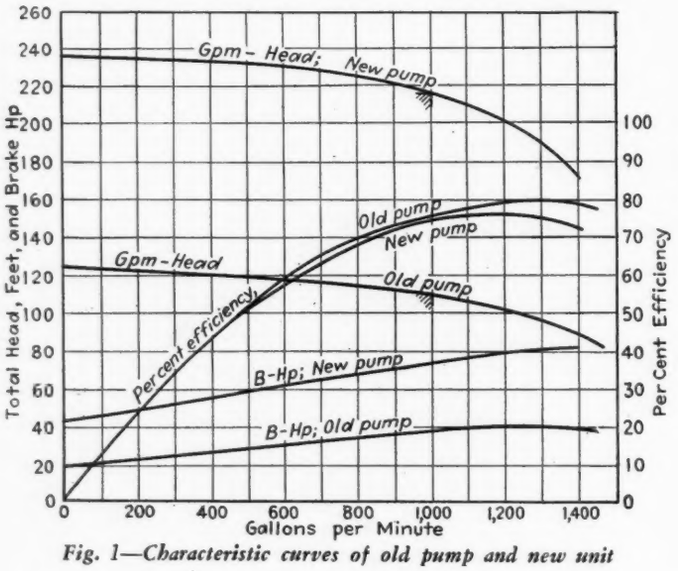


Fig. 1—Characteristic curves of old pump and new unit

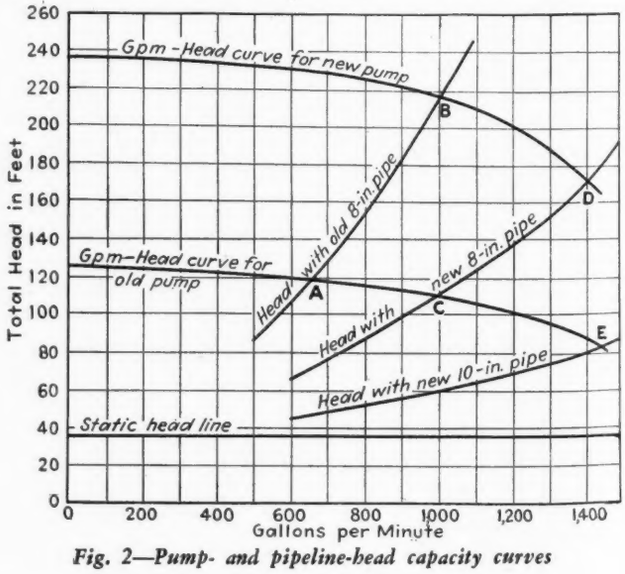


Fig. 2—Pump- and pipeline-head capacity curves

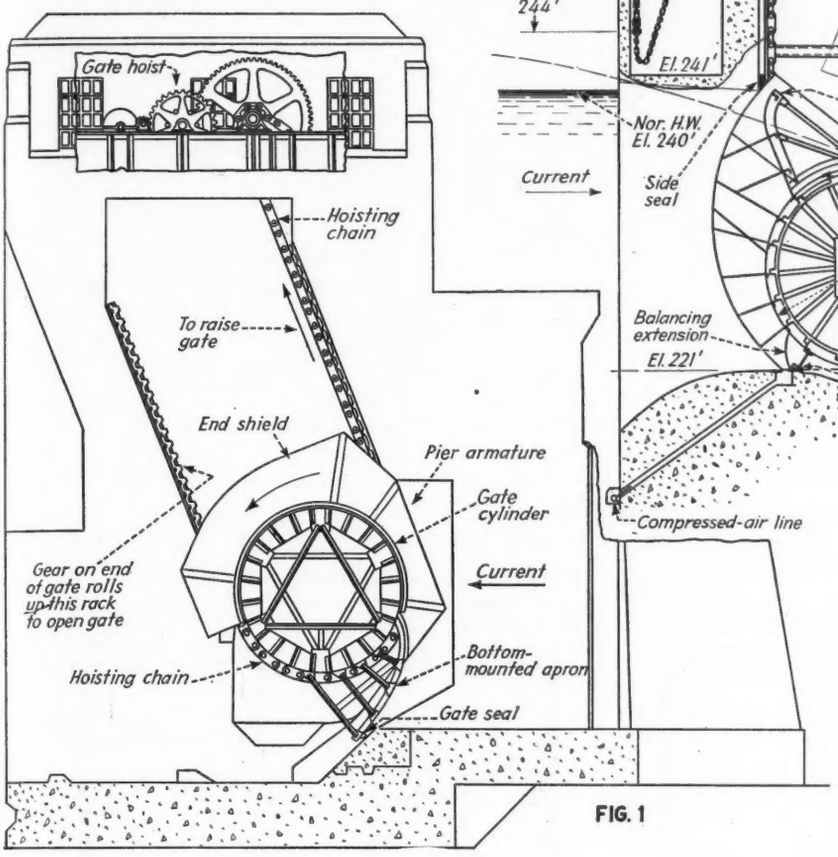


FIG. 1

Fig. 1—Cross-section through conventional design of roller gate, opened by rolling up a steep incline

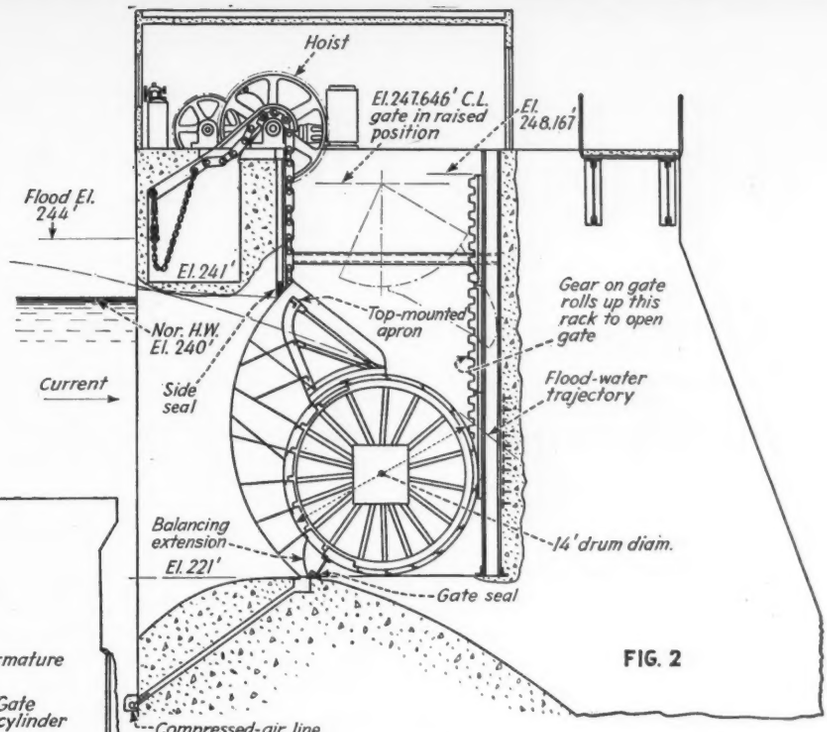


FIG. 2

Fig. 2—Cross-section of a 92x19-ft roller gate which is designed to obtain balanced water pressures and to lift vertically

By C R MARTIN
Engineer, Allis-Chalmers Mfg. Co.

Roller Gates for Hydro Plants

A ROLLER GATE is a long cylinder, built of steel plates, on a structural-steel frame, placed between two piers in the spillway section of a dam. A gear, fixed to each end of the cylinder, meshes into a rack on a steep incline, Fig. 1, or is supported vertically, Fig. 2. A hoisting chain fixed to each end of the gate makes a half wrap around the end of the cylinder, and connects to a power-operated hoist at the top of each pier, Fig. 2. To open the gate, the hoist winds up the chain and causes the gear at each end of the gate to roll up the rack.

This type of gate, of which 146 have been built in the United States, can be made economically in long spans, 80 ft or more in length, and with a depth of 20 to 40 ft. Large quantities of water can be discharged through comparatively short lengths of dam. Concrete work is reduced because less volume is required per foot of dam and by a smaller number of piers. Shorter length of concrete work for the gate or gates permits making a greater length of the dam of a less expensive construction, such as an earth fill.

A roller gate, 80 ft or more in length, will not plug due to bridging of ice between piers and it can free itself of ice by its own power. Since it is not necessary to have someone present when the gate is opened, the operating control can be placed in the generator room. For a roller gate to be economical, the savings in over-all cost of the dam, the cost of operation, and the cost of the gate itself must represent an over-all saving compared to other forms of gates.

Fig. 2 shows a cross-sectional elevation of a roller gate that meets these design requirements. The apron is on top of the drum and upstream. As the gate is raised, the apron pulls away from the ice sheet and the drum can clear the ice formation. Ice pressure against the top of the apron creates an opening movement. The gate can open slightly to allow for expansion of the ice sheet. This movement will not cause leakage because the bottom and side seals will adjust for the new position of the gate. A balancing extension is necessary at the lower upstream quadrant of the gate to overcome the opening movement caused by placing the apron on top of the drum. This balancing extension also serves as a discharge orifice of great rigidity to resist the hammering action of floes as they pass underneath the gate.

A gate made in this manner has many advantages, such as direct vertical lift; small amount of power required to raise the gate due to its balanced arrangement of apron and drum extension; smaller piers for resisting a low overturning moment; and reduced weight.

Hanging Up the Air Receiver

A compressed-air installation is no better than its air receiver mountings, and there are several ways of properly doing the job. Here's how to make your choice

BY HARRY M SPRING

PROPER MOUNTING of compressed-air receivers is an important factor in the success of every compressed-air system. The American Society of Mechanical Engineers recognizes the potential hazard of poorly mounted compressed-air receivers and has listed rules for their construction and installation, based on latest knowledge and developments. These rules are published in the ASME Unfired Pressure-Vessel Code. State boiler-code committees, too, are recognizing the need of incorporating air-tank regulations in their boiler rules, and several states already have adopted the ASME Code.

The requirements of some states are quite broad in specifying actual methods of receiver installation, often leaving the decision to the judgment and common sense of the one making the installation. Because of the differences in opinions on how air receivers should be supported, a few acceptable methods are here presented.

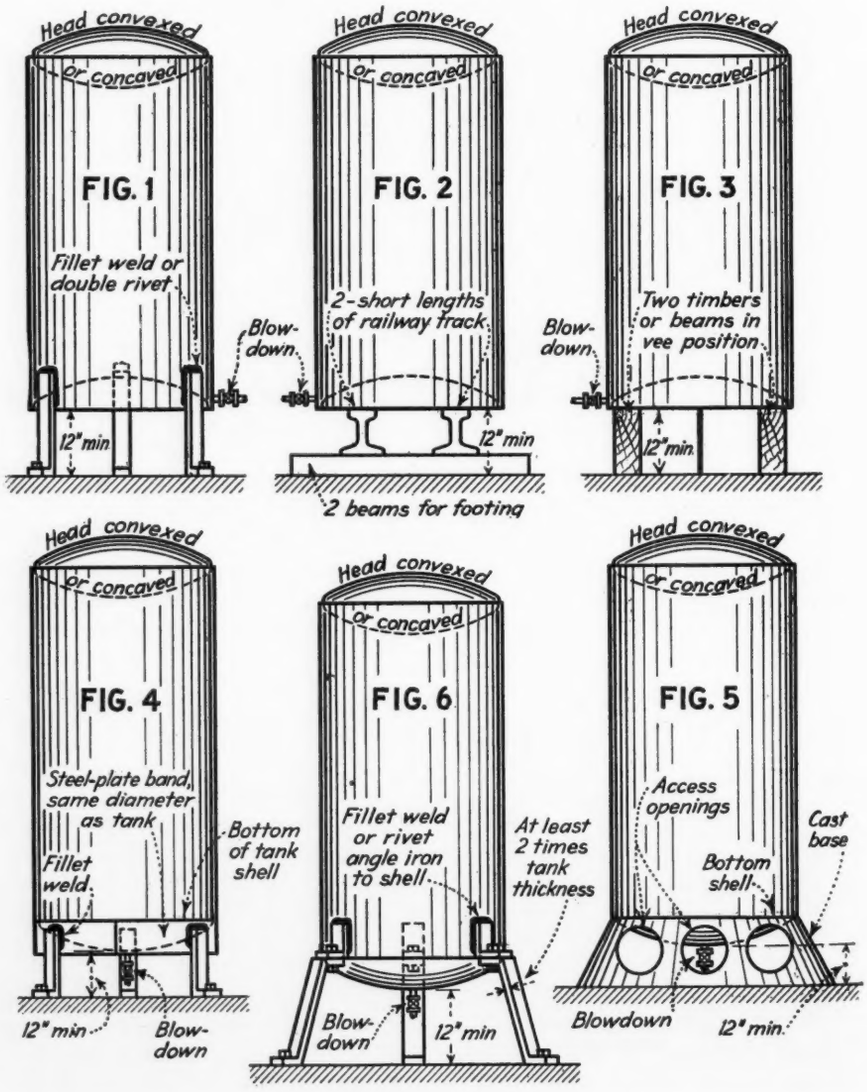
Types of Mountings

Air-receiver tanks may be mounted either vertically or horizontally. Their heads are dished in or out. It is not advisable to install an air-receiver vertically with a dished-in head at the bottom because it is impossible to place the blowdown where it will drain the tank completely. However, details peculiar to a particular installation sometimes make it impossible to avoid doing this. If it is necessary to use a vertical tank with the lower head dished-in, the blowdown should be put as low in the shell as practicable.

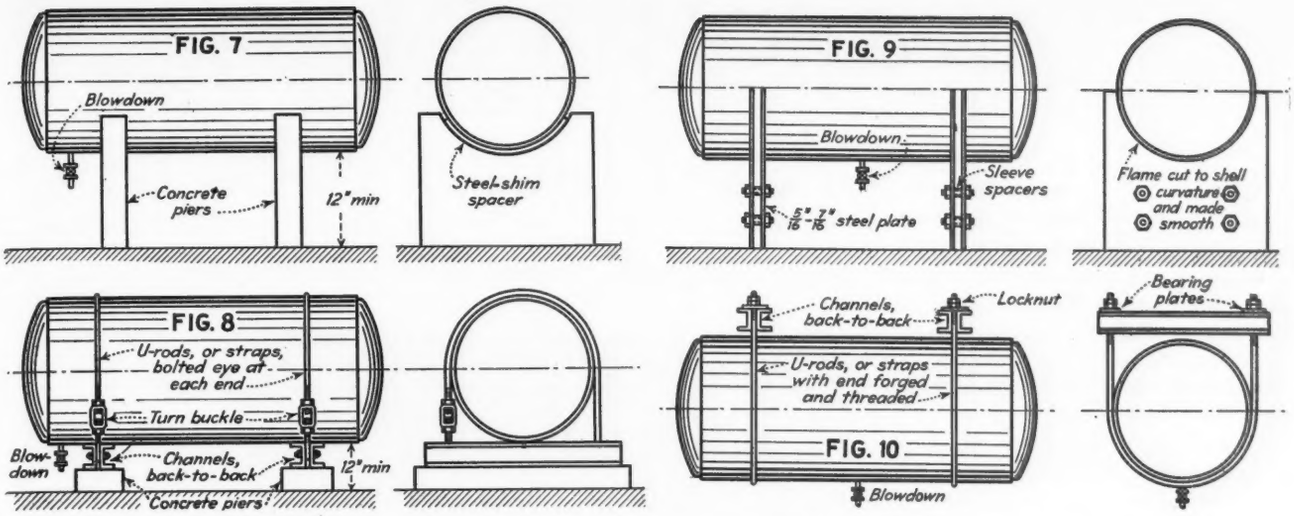
Provide a 12-in. clearance under the receiver so that external defects can not develop unnoticed. Do not set a vertical tank with the lower head dished-in directly on the floor. Figs. 1, 2 and 3 show acceptable methods of installing this type of tank. In Fig. 1, bolts or rivets are sometimes used for attaching the legs. This construction is made pressure-tight by grommets under the bolt heads or nuts and is often selected if the legs are attached when the tank is built. Mountings in Figs. 2 and 3 are usually used for correcting existing installations in the field.

If, to conserve floor space, or for other reasons, the tank is to be placed in a vertical position, it is best to specify that the lower head be dished out. Complete drainage can be assured by putting the blowdown in the lowest part of the bottom head. Three ways of supporting these tanks are shown in Figs. 4, 5 and 6. If legs are welded to the shell, or riveted to large, heavy tanks, the design should be checked by an authorized inspector before proceeding with this work. Some states require this, and it is advised for a check against excessive stress concentration at points of attachment.

Method of Fig. 4 comprises a ring



Figs. 1 to 3—Three ways of supporting vertical air receivers having concaved lower heads. Figs. 4 to 6—Three ways of supporting vertical compressed-air receivers having convexed lower heads on separate bases



Figs. 7 to 9—Floor mountings for horizontal air receivers. Fig. 10—Method of hanging air receiver from overhead

made from steel plate, 8- or 10-in. wide, and about the same thickness as the tank shell, with its ends bevelled and butt-welded together. Three steel legs are welded, riveted, or bolted to this band which serves as a base onto which the lower end of the tank is fitted. Fig. 5 calls for a cast base, carried in stock by some manufacturers for standard sized tanks. It is important that the base be provided with access openings of sufficient size to permit inspection of the lower head.

Horizontal Supports

Where head room is at a premium, or for other reasons, it is necessary to mount air receivers in a horizontal position. The constructions, Figs. 7 to 9, are approved methods for mounting receivers on the floor and Figs. 10 and 11 for ceiling supports. When using concrete piers or cradles, install steel shims to prevent direct contact of concrete on the tank shell, because the tank may sweat, or moisture may collect in the cradle and external corrosion may progress unseen to a serious extent. It is not uncommon for external corrosion to be accelerated by an acid content in an unshimmed concrete cradle. A second source of trouble when shims are not provided is abrasion of the shell by the concrete, caused by a slight motion of the tank due to pulsations in piping from compressor.

If method, Fig. 11, is used, the supports should be placed close to each head, because the concentrated load on the tank bottom comes at a point where the shell is stiffest. Selection of receiver should be based on cost and adaptability for existing conditions. Turnbuckles or nuts are required on U-bolts or tie rods in order to anchor the tank securely; don't draw these up so tightly that over-stressing or distortion of the tank occurs.

If reciprocating or rocking motion of the tank is observed after installation, it should be corrected, but not by attempting to anchor the tank more rigidly. The motion does not originate in the tank, but in the piping. Under these conditions, the pipe connections may be damaged if the tank is made rigid and the cause of pulsation not corrected. The pulsations may be caused by movement of a compressor not on a stable foundation, being transmitted through the piping; a number of sharp bends in the piping; a pulsating load; or too small a tank volume for the air flow.

Trouble Correction

To correct the first condition properly, install the compressor on a stable foundation. Condition two is caused by reaction of sharp pipe bends to airflow pulsation, and may be corrected by substituting long-radius bends for 90-deg elbows in the piping, and, if necessary, use a larger pipe size. Conditions three and four are closely related. If load pulsates greatly as in drop-forging hammers, it is advisable usually to provide a secondary air tank of proper volumetric capacity near load center. If the primary tank is too small for the load, the compressor will be starting and stopping very frequently. This condition can be corrected only by installing a larger, or a second tank.

The inverted U-bolt method, Fig. 8, of mounting horizontal air receivers is desirable where there is little head room or no facilities for tying the tank up to an overhead structure. Two sets of channel irons, set back to back, serve for a base. The minimum clearance all around should be 12 in., but this does not necessarily mean that 12-in. channel irons should be used. If shallower channels are desired, they should be footed by a timber or flat iron base so as to elevate the tank 12 in. from the floor. The U-bolts are forged to an eye at each end, and a turnbuckle is provided in each on one side of the tank to permit the tank to be fastened rigidly. Care should be taken, however, not to draw down the turnbuckles too tightly to cause excessive stress or distortion of the tank.

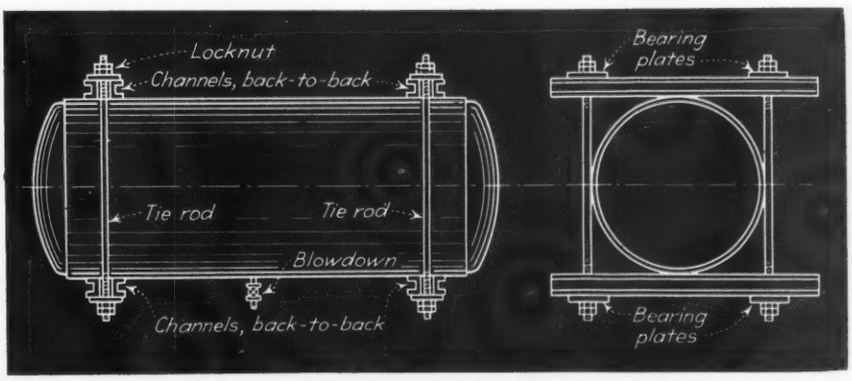


Fig. 11—Bolt and channel hanger for air receiver

Electric Heat Solves Air-Filter Problem

BY F A MUELLER, *Cleveland Electric Illuminating Co*

TO KEEP OUT FUMES and dirt injurious to motor windings and to reduce maintenance costs, all air to the motor room of the 77-in. hot mill of the Otis Steel Co is filtered. These filters, large oil-saturated screen belts, slowly rotate through an oil bath at their lower end. The oil cleans the screens of dust and dirt to keep them in good working condition and the oil on them collects dust and dirt more readily than a dry surface.

As originally installed, the oil did not sufficiently clean the filter screens and compressed air was added to agitate the oil. This worked satisfactorily until winter; then the oil had a tendency to become too viscous. Experiments showed that oil temperature should be maintained between 90 and 105 F to obtain most effective cleaning of the screens.

To heat the oil baths, a safe, dependable source of heat was required that could be controlled automatically. This problem was solved by installing eleven 4-kw immersion-type General Electric heaters in the oil baths as shown in the photos. These are controlled by thermostats with the detecting element immersed in the oil bath. By increasing efficiency of the filter screens, running conditions of the motors have been improved and maintenance work reduced.

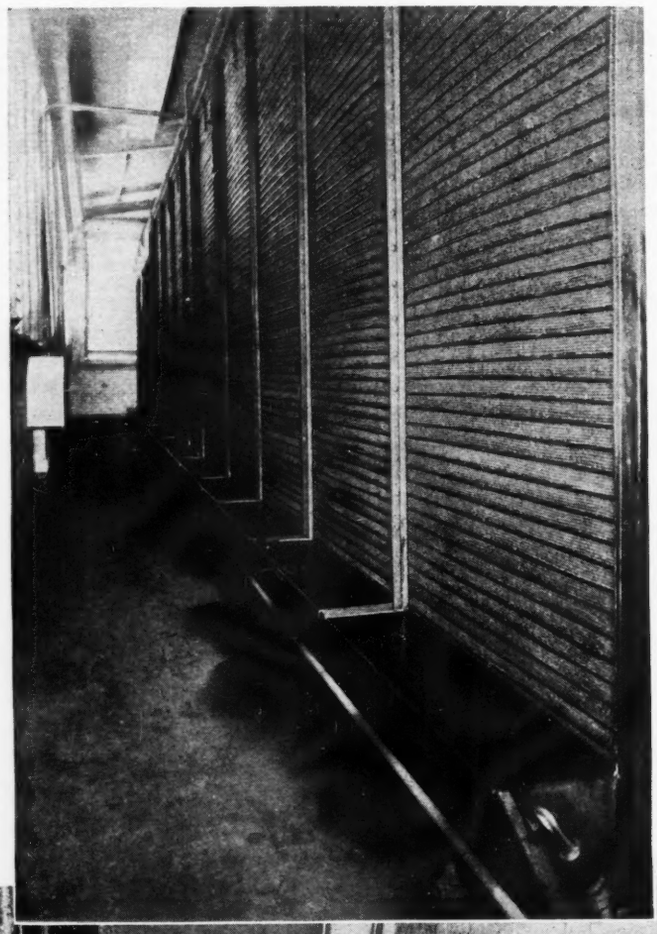


Fig. 1 — Filters clean the air of abrasive dust and injurious fumes before it goes to 77-in. hot-mill motor room of Otis Steel Co

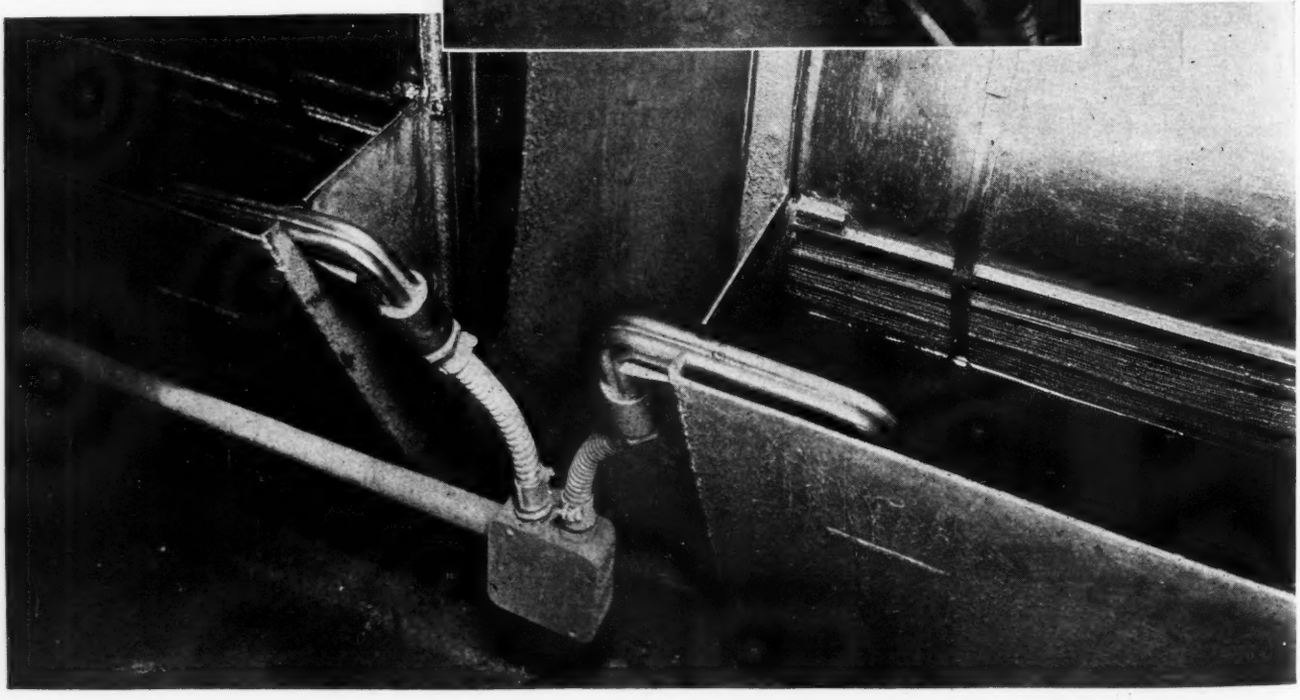


Fig. 2—Close-up of two of the eleven 4-kw immersion electric heaters used to maintain temperature of air-filter oil bath between 90 and 105 F

THE OPERATING ENGINEER

George Edwards
Advisory Editor

Operating Aids
Maintenance Hints
Questions — Answers

Published monthly as an integral part of POWER

It's Your Baby

MORE YEARS ago than I care to admit, we were putting together a brand-new planer. "George," says the Boss, "Because you've been doing so much talking about how this machine ought to be run, let's see you run it. *It's your baby!*"

Right then, I found out about talking too much. I had to make tools and clamps, had to get the machine running right—and, worst of all, I had to teach myself how to run it. I should have known better, but I was just an apprentice then.

Well, I'm an apprentice all over again. For a couple of years, I've been complaining to Phil Swain, "Too much tops and high pressures! You editors let your nose for news run away with you. Sure, we want to know all about this big, fancy stuff, but we small fellers want dollars-and-cents pointers about running our own plants, too. We may not have the biggest or fanciest plants, but I'll bet that together we burn more coal than the big ones. How about a magazine just for us?"

"George," Phil would insist, "It's in POWER, but you just don't see it!" And he'd proceed to show me. I never saw such a man for arguing! But I couldn't take every issue of POWER to him just to find out where the help for me was. So, I kept on kicking.

A couple of months ago, I started in to kick again. But this time Phil had a new answer. "George," he said, "You win! We're going to put out an operating engineer's magazine—right in POWER. And we'd like you to be editor-in-chief."

"Hey, listen," I yelled, "You can't make a comma chaser out of me! I have troubles enough keeping steam up."

"But it's your baby, George," says Phil, reasonable-like. "And I haven't told you the whole story. We're not trying to make a comma chaser out of you. We editors are going to get hold of, and put together, every month, the things we think you particularly want. I know you don't want to be anything else but plain George Edwards, but we need help. We'd like to have your advice as a practical engineer, and to call you advisory editor."

A flatterer, this man Swain. What did I do? Well, what would you have done? After all, it was *my* baby that was being born. The upshot of the whole thing is that I bit. The boys on POWER do all the work, and chase all the commas, but then if I say "No!" it doesn't go in.

Here's the first sample. Have we got something here, or should we change it some more? I'm no editor, and neither are you, but maybe together we can show these pencil pushers something. You tell me what you want, and by heaven, I'll holler 'til we get it. I may be the mother of this infant, but you, the whole bunch of you, are its fathers! So if you want to be Assistant Advisory Editors, advise away! And if, instead, you have ideas, send 'em in. This is your baby as much as mine!

George Edwards
Engineer

NOTHING FANCY

But This Laundry Plant

THIS is no story of a "model plant." The power setup of Sun Laundry Co, 2031 La Fontaine Ave, Bronx, New York, is not much to look at. Chief engineer Robert Dick would be the first to admit that. He will tell you that his boilers, engines and generators are quite old, that it's hard for a laundry engineer to get money for new equipment. And in the next breath he'll tell you he is getting results and has the figures to prove it.

Sun Laundry averages about 14 lb of steam gross per pound of Bunker-C oil. That spells low fuel cost for steam. Supervision and labor costs are low, since only one man, Bill Dick (the boss's son and assistant), devotes full time to the power plant. Chief Dick and his maintenance men spend more than half their time on laundry problems outside the "power house"—power problems, but charged to distribution rather than generation. Cost of steam, including fuel, supplies and chargeable labor and supervision, is only about 37 cents per thousand pounds—low for this neck of the woods.

Application is equally economical. More than half the steam goes through engines, then to process and heating. Practically no exhaust is wasted in winter and not more than 10% average in summer.

The table of operating figures for December, 1938, gives an idea of the general scale of operation. During that month, Sun turned out about 500,000 lb of laundry, thus ranking it as one of the larger laundries of New York City, but by no means the largest. The month's electrical generation was 30,716 kwhr.

Feedwater averages about 212 F, CO_2 13 to 14%. Boilers normally operate 10 to 12 hours daily, 5 days a week. Steam pressure is 110 lb.

Average actual evaporation is about 14 lb water per pound of fuel oil. The "Bunker C" burned now costs 2.65 cents per gal. of 8.25 lb, making fuel cost of steam about 23 cents per thousand. Adding labor and supervision, but not fixed charges, brings total to about 37 cents. The whole establishment uses between 2 and 2½ million gal. of water per month, mostly for laundry purposes.

Robert Dick first came to this plant as chief back in 1924. It was a hat factory then, not a laundry. Generating equipment consisted of two American Ball engines, one 50 kw and one 35 kw, furnishing 220-volt dc current.

There were three Titusville hrt boilers, hand fired with anthracite buckwheat No. 1. Two of these boilers, 900 sq ft each, were hardly fit to operate. The other, a 2000-sq ft job, would run, but not efficiently.

Plenty Wrong

Dick found plenty wrong—for example, a very bad feedwater arrangement. Believe it or not, a 6 by 4 by 6 duplex pump had to serve for both fire pump and boiler-feed pump. This took water from the open heater. Part of the discharge (at 120 F) was bled off to the two small boilers. Then the remainder was dumped into a closed heater, which raised water temperature to 180 F for the large boiler.

The boiler was not permitted exclusive use of this water. The pump had also to supply dye vats on the fourth floor, so operation was a wild merry-go-round. First the dye vats would grab a big batch of the 180-F water, starving the boiler. Then the operator would have to cut off the dye vats long enough to prevent low water in the boiler.

No steam man with a conscience could stand for this kind of operation, so Dick's first job was to repipe this system completely. No more hot *feed* water to dye house, for example! He rigged a tank with an exhaust-heated coil to supply water to the vats, exclusively, at 180 to 190 F. In addition to a 3-hour daily saving in the dye-house operation, this insured all three boilers getting feed at 190 to 200 F.

Immediately coal consumption dropped by 75 tons monthly, for which engineer Dick was rewarded with a $25 raise in his weekly salary. By the end of 1926 further savings had earned him another $25 raise, plus a bonus of $75 every three months.

These happy days continued until 1928, when the hat factory closed down and Dick took a temporary job elsewhere. However, he spent part of his time keeping an eye on the plant and was called back again as chief when Sun Laundry Co (under United Power Laundries) bought the plant in 1929.

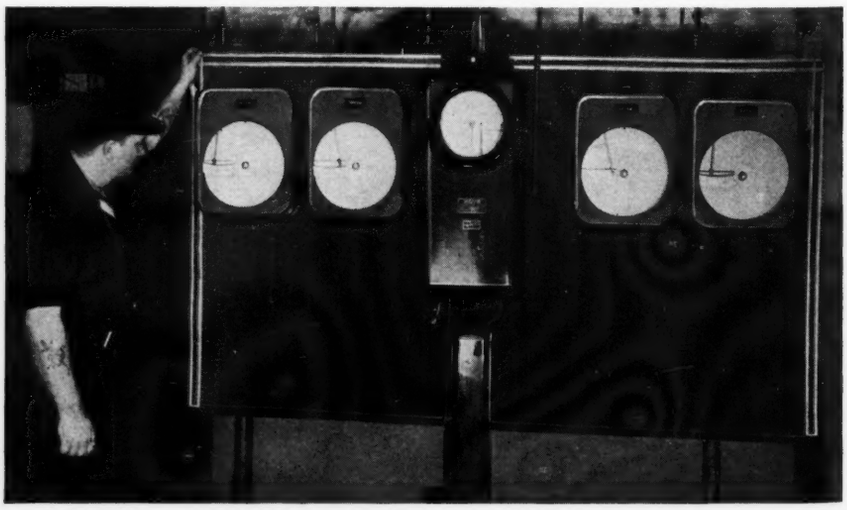


Fig. 1—William Dick, the chief's son and assistant engineer, inspects the new instrument board at Sun Laundry Co, Bronx, N. Y.

Gets Results

Though equipment is simple and money for improvements comes hard, Chief Robert Dick and son Bill, Sun Laundry Company, have cut steam power costs to 37 cents per thousand pounds

More power was needed, but little money was available for equipment—a typical laundry situation. In September, 1929, Dick spent $2500 for a used 100-kw, J L Ide & Son piston-valve engine (shaft governor) and generator. He and his helpers installed the unit with little outside assistance. In October, 1931, he spent another $3800 (plus installation) for a used 200-kw, 4-valve Erie Ball unit. Both were 220-volt, dc.

Change to Oil

About the same time the chief changed all the boilers to oil, with spectacular results. The immediate saving in fuel alone was $475 per month, partly from the shift to oil and partly from furnace and other improvements.

Dick does not figure any labor saving from this fuel change, for he would need an attendant in any case. He equipped each boiler with a single Staples and Phifer flat flame ("400-hp") burner and installed the necessary pumps and heaters to handle Bunker C.

Dick's ideas about oil burners may not agree with everybody's, but he seems to get results. He put same size burner in all boilers to reduce needed stock of spare parts. For low-set hrt boilers, he likes the flat-flame horizontal burner, because it "streamlines through furnace and doesn't overheat shell or girth seam." He doesn't believe in "targets" or arches. His furnaces are simple boxes with heavy tight firebrick walls, steel-cased in front. For such boilers he definitely prefers simple steam atomization to mechanical burners; feels that the 3% of steam consumed is more than justified by saving in first cost and other advantages.

[Some readers won't agree with these opinions and our pages are open to brief arguments on the other side—Editor.]

Steam load now is less than at time of oil-burner installation. With present oil and coal prices, and present steam load, Dick figures the fuel saving is about $375 monthly.

As already indicated, this saving was obtained by many improvements, aside from the shift to oil fuel. For example, the combustion-chamber floor behind the bridge wall in the No. 1 and 2 coal-fired boilers was only 2 in. below the top of the bridge wall, or 16 in. below the shell. Evidently, somebody didn't like to excavate. Dick did—he tore out the bridge wall and brought the furnace floor throughout down to the old ash-pit floor level.

As now set up, the small boilers can be operated up to 160% rating and the large boiler close to 200%.

Making Savings

Like most power engineers serving buildings, institutions or industrial plants, Chief Dick is as much concerned with application as with generation. He believes that a saving in one place is as good as in another. For example, a lot of his high-pressure steam goes to mangles, pressing machines and similar laundry processes. The trapped condensate from these machines is now carried to a common return, and first flows through a coil in the tank used to heat process water (first floor of laundry). Next it goes to a flash tank. The flashed vapor wastes to atmosphere and helps remove oxygen from system.

The water then gravitates to the open heater in the boiler room. From open heater it goes to duplex feed pump at 160 F, then to closed heater and finally to boilers at 212 F or even higher.

To provide greater comfort for laundry operatives, and save the time they used to spend running to the spigot

Fig. 2 — Titrating a sample of boiler water for alkalinity

Fig. 3—Bill Dick "takes a sight on the lamp" to determine sulphates in his boiler water. Note complete testing equipment

for a drink of water, Dick recently installed a continuous circulation chilled-drinking-water system.

Here, as usual, money was lacking. The plant force did the piping and the chief picked up a used 5-ton Frick ammonia compressor for $450. For $90 he found a motor to drive it.

The reader should not get the idea that this plant operates entirely with old or used equipment. One example of new stuff is the instrument board shown in Fig. 1. Its only homemade features are the installation and the black-painted presswood board. Left to right, those instruments are:

Instruments

(1) Flowmeter for Boiler 3, (2) flowmeter for Boilers 1 or 2 (one operated at a time), (3) combustion meter (CO_2 and over-fire draft on Boiler 3), (4) flowmeter for steam to engines, (5) flowmeter for all live steam above engine-room floor (flowmeters are Cochrane, combustion meter is Hays).

Dick bought these instruments to use, not to look at. It's hard enough to get money for instruments, he says. When he gets an appropriation he puts the new equipment to work keeping down operating costs, not as boiler-room ornaments.

Another modern touch in this rather old-fashioned plant is the Hall system of water control, operated by the younger Dick. Water is treated with Buromin (phosphates) sodium sulphate and Santosite (sodium sulphite) to protect boilers against scale, embrittlement and corrosion.

With the old-style boiler compounds he formerly used, chief Dick cleaned scale twice yearly. Now he opens boilers once a year for washing and inspection and arranges to have both city and insurance inspectors present to make it a complete job. This is a Scotch trick, because it costs about $45 to open a boiler here.

HIGH-PRESSURE STEAM DISTRIBUTION

(Totals for December 1938; M = 1000 lb)

Boiler Room		
Gross steam generated		3,102 M
To oil-burning auxiliaries	65 M	
To other boiler-room auxiliaries	69 M	
Total to auxiliaries		134 M
Net steam delivered by boiler room		2,968 M
Application		
To engines* (including condensation in mains)		1,766 M
To laundry finishing dept.		1,133 M
To outside customer		65 M
For process-water heating**		4 M
Total		2,968 M

* All exhaust used in winter—about 90% in summer.

** This is "make-up" steam; water heated mainly by exhaust.

HOW TO TEST FIELD-POLE POLARITY

IN REASSEMBLING d-c machines, after repairing, workmen sometimes connect some of the field coils to give them wrong polarity. This mistake can be prevented easily by a few simple tests, before and after the coils are assembled in the machine.

When ready to assemble the machine, place the polepieces in the field coils—then connect the coils in series, energize them from a power source (Fig. 1) and test with a compass. If you haven't got a compass, a couple of steel nails or a piece of iron will serve very nicely.

When the coils are properly connected the compass needle will point in opposite directions when placed in front of one polepiece, then in front of an adjacent polepiece (Fig. 1). If one coil has reversed polarity, then the compass will point the same direction when in front of three adjacent polepieces. To correct this condition it is only necessary to disconnect the center coil of the three, rotate it 180 deg, keeping the pole piece facing in its original direction. Then, connect it back into circuit. Repeat compass test to make sure connections are correct.

Always repeat tests until absolutely

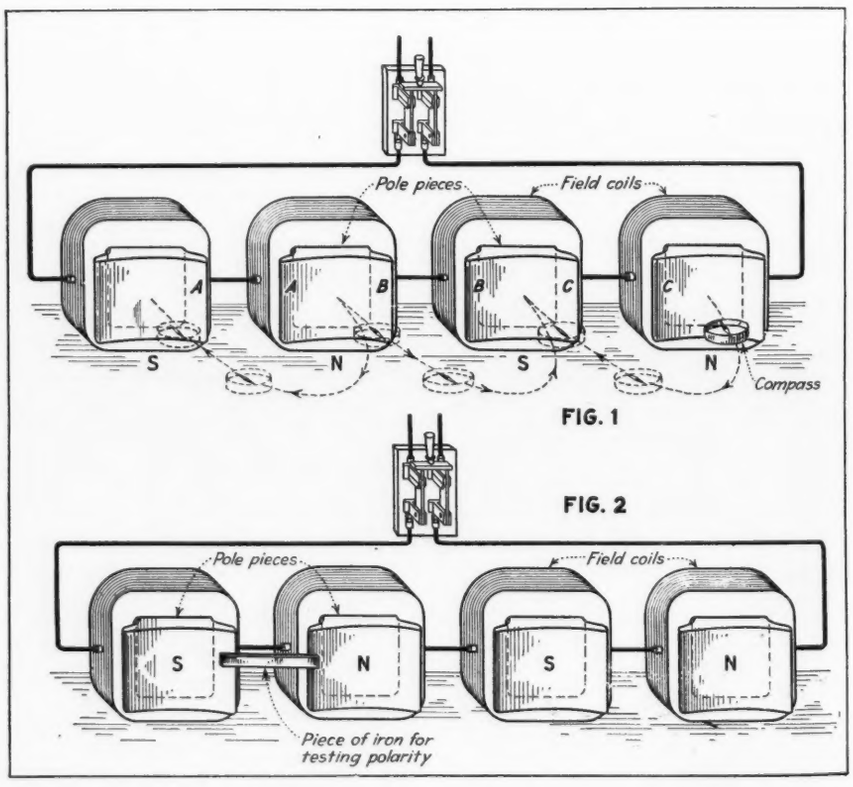


Fig. 1—When coils are connected correctly, compass needle will reverse at alternate poles. Fig. 2—Adjacent polepieces will attract a piece of iron with a strong pull if they have correct polarity

sure your results are correct. Carelessness in testing can cause a lot of trouble because of some fault that should have been found by the test. When using a compass, make sure the needle is free to move *at all times.* Tipping a compass so that its needle cannot move when put in front of a polepiece may reverse the polarity of the needle and cause an error in testing.

A piece of iron may be substituted for the compass. Place the iron to bridge two adjacent polepieces (Fig. 2). If the coils are connected correctly, the iron will be attracted with a strong pull. Two adjacent poles of the same polarity will tend to repel the iron, or develop only a weak pull if the iron is brought into contact with them. If the iron is moved gradually toward the polepieces the force of attraction or repulsion will be quite evident.

Where the field coils are to be tested without the polepieces in them, a nail balanced on the end of a thread can be used in place of a compass. The nail is first placed in one coil until it is magnetized, while supported on the thread. Then it is moved in a half circle from one coil to the next, as shown in Fig. 1. When the coils have correct polarity the nail, like the compass needle, will reverse in adjacent coils. When you move the nail from one coil to the next, make sure that its polarity is not reversed. Better repeat the test two or three times to make sure that your results are correct.

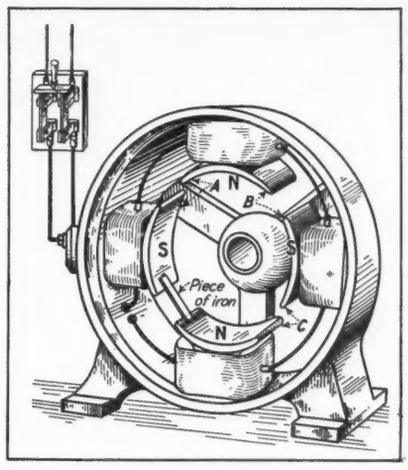


Fig. 3—After field coils and polepieces are assembled in the field frame, test them again to make sure you are right

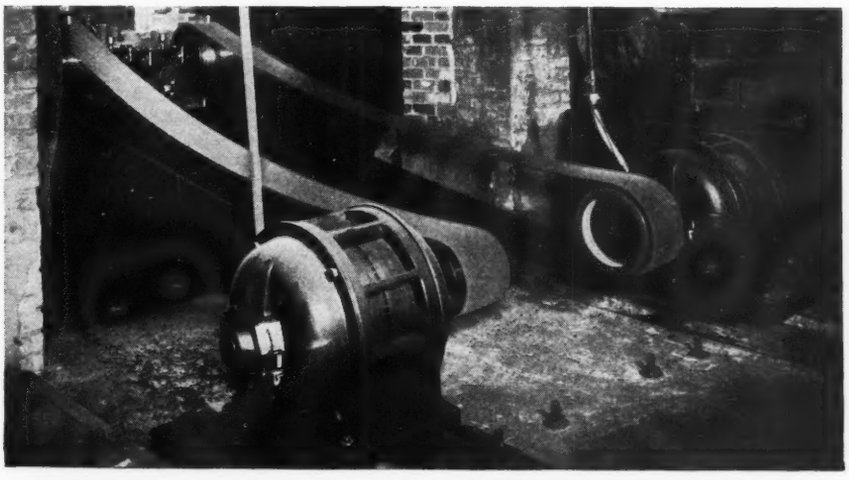
After you are certain that the coils have alternate *N* and *S* poles, as indicated in Figs. 1 and 2, mark each coil or polepiece so that the proper relation between them can be maintained when they are placed in the machine. Place the coils in the machine to maintain the same relation one with the other as when tested. After the coils are connected test them again for polarity. If a compass is used be sure that its needle is free to move when you bring it near the polepieces.

A piece of iron can be used to make the test by bridging it from one polepiece to the next, as in Fig. 3. Be sure that you get a strong pull on the iron from any two adjacent poles. If the two poles have the same polarity a weak pull will probably be obtained; do not mistake this for the strong attraction when the two poles have opposite polarity.

Always remember that accurate test results are obtained only by those who take time to be sure they are right. Don't be afraid to do a little testing with one of the coils connected incorrectly, just to become familiar with the results you obtain and be in a better position to judge what is correct.

When you are sure that you have the field coils connected correctly, complete assembly of the machine.

Sweet-Running Belts



"Here's my idea of a correct flat-belt drive," says Campbell

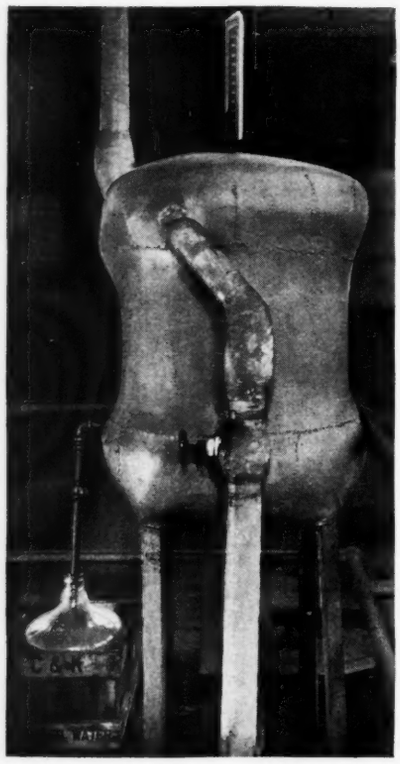
PLANT ENGINEER H A F Campbell, Geo F Keith Co (Walk-Over Shoes), Campello, Brockton, Mass., is a booster for the "good old-fashioned flat-leather-belt drive", and he wants his belts oak tanned. Also he considers that first-class sleeve bearings, amply large, with box hangers well anchored and aligned, are essential.

From long experience with such drives, E Ward, chief machinist at the Keith plant, offers the following advice to leather-belt users:

1. Use cemented joints, scarfed true, with joined ends lined perfectly.
2. Don't use too small a motor pulley.
3. Use a leather-faced motor pulley where possible—one with a steel or iron core.
4. A wide, thin belt is a lot better than a narrow, thick one.
5. Use belt wide enough to run fairly slack (saves belt, saves motor bearings, saves power).
6. Line up pulleys perfectly.
7. On vertical drives have shafts far enough apart to give good arc of contact on motor pulley.
8. On horizontal drives, too, keep pulleys far apart and run with slack on top to give maximum arc of contact, particularly on motor pulley.
9. Always remember that a little more belt wrap means a lot more grip on the pulley.
10. Line shafting must be large enough, set up very securely and with great care, and *kept* set up.

Photo shows two flat-belt fan drives in plant of Geo F Keith Co. Note large center distance and heavy sag of top. Even bottom run is fairly loose; this means long life for belt and motor bearings. Each squirrel-cage motor shown is 970 rpm, 20 hp.

PRACTICAL AIDS TO OPERATION



Fume Condenser Saves $170 Yearly

THE CARRENE centrifugal refrigerating machines in the plant of the New England Confectionery Co, Cambridge, Mass., formerly vented the "foul gas" from purge pump directly to atmosphere. Since this involved a considerable waste of expensive refrigerant, Chief Engineer S Peter Starratt had a condenser built to recover the Carrene in the purged gases.

Purged gases enter the condenser at top (see photo) and pass down through two vertical helical coils, each containing about 30 lineal feet of $\frac{5}{8}$-in. copper tubing. Cold brine circulates through shell around coils. Condensed Carrene drips into carboy sealed against evaporation by 1-in. layer of water floating on top the heavy liquid.

Recovery averages 5 gal. per month, or 60 gal. per year. Refrigerant costs about $86 per 30-gal. drum, so saving is around $170 per year. FIELD EDITOR

Klaxon Signals Boiler Room

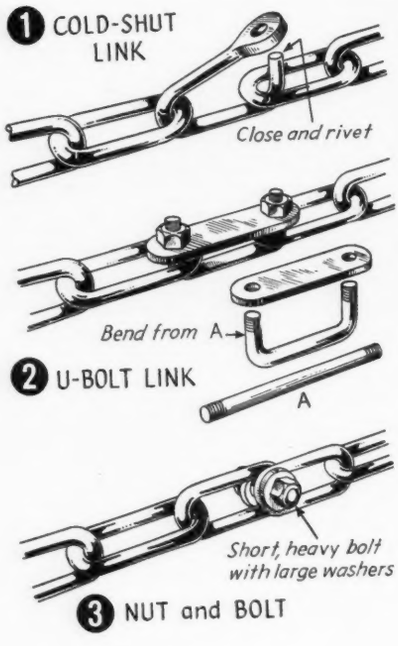
IN THE modern office building, the various mechanical departments must often be on different underground levels. Communication becomes important and electric signals are often necessary. M J Peterson, plant engineer and building superintendent, Hotel Statler Building, Boston, Mass., has installed a Klaxon signal system connecting engine room and boiler room.

Engine room signals boiler room in advance if it is planning to start or stop main turbine, so that the boilers may be gotten ready for the swing. This prevents the safety valve popping when the turbine is shut off and insures ample steam when turbines are started.

FIELD EDITOR

Quick Temporary Chain Repairs

SKETCHES show handy ways to make temporary repairs of broken chain. Cold-shut links (1) can be made up in various sizes and stocked for possible emergency use. U-bolt type (2) is equally strong and can be made up cold without a forge. Where cold forming the U from heavy rod, avoid too sharp a bend, which might weaken the rod.



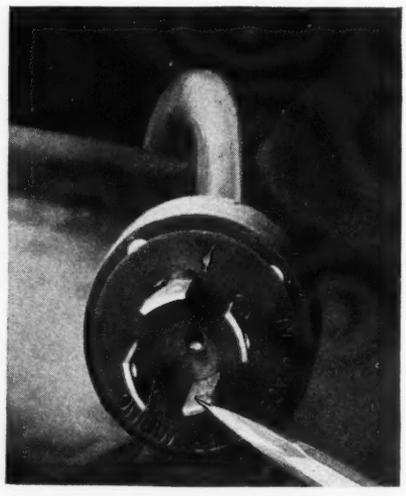
The bolt-and-nut method (3) is simplest (using stock parts) but may be dangerous in careless hands. Use largest possible bolt diameter and very heavy washers. Watch out for bad skewing. In case of doubt don't use it.

In fact, all types of emergency links should be used with care. Better weld in a permanent link at first opportunity.

Penacook, N. H. C H WILLEY

Three-Phase Plug

WITH new-type flexible cable and connections, approved by most electrical codes, it is now possible to plug in a factory machine on 3-phase, 220-volt power circuit as you would plug in a bridge lamp at home. Photo shows plug used on "staple-side-laster" machines in the new Walk-Over Shoe Factory of Geo F Keith Co, Campello, Brockton, Mass.



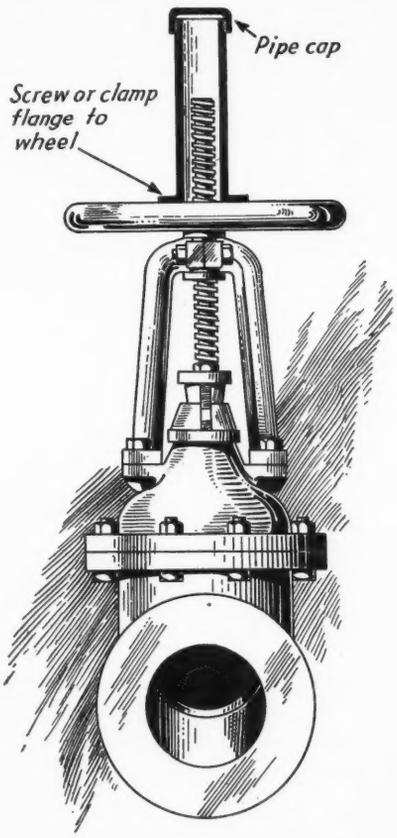
Pencil indicates grounding prong, longer than the phase prongs, to insure grounding before connection

As explained by chief electrician

F W Moore, who applied these connections to all staple machines, the heavy-rubber covered cable carries four conductors, one for grounding and one for each of the three phases. While fairly short, cable permits two or three feet variation in machine location without shifting junction boxes. Of the four prongs of the plug shown, the ground-wire prong (indicated by pencil) is longer than the other three, thus insuring grounding of the machine before the phase connections can be made. Also, this plug is of twist-lock type, giving tight connections.

FIELD EDITOR

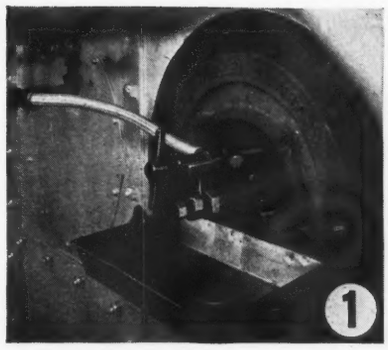
Cap Protects Valve Stem

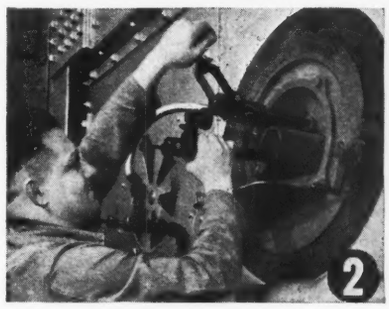


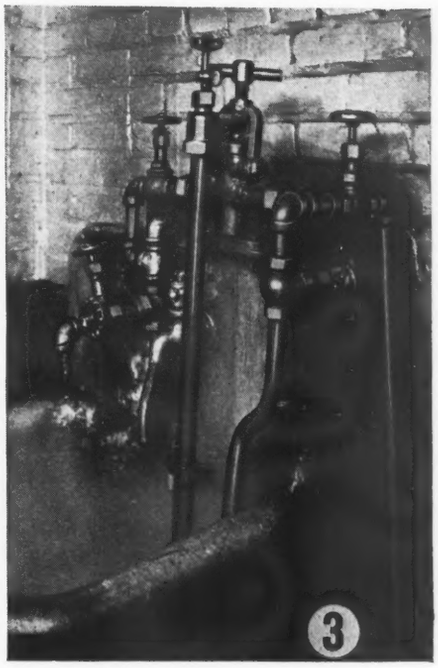
WITH the usual routine cleaning and lubrication, threaded stems of open rising-stem gate valves will give little trouble if valves are indoors in a clean spot. Stem threads of outdoor valves should be protected against rain, dirt, dust, knocks, ice accumulations and over-diligent painters. Same applies to indoor valves in exposed locations.

Sketch shows protective cap attached directly to hand wheel. Upper part is made of pipe section and cap. Lower flange may be welded or screwed on. Flange should be locked to wheel with machine screws, U bolts or other fastenings.

Roanoke, Va. S H COLEMAN







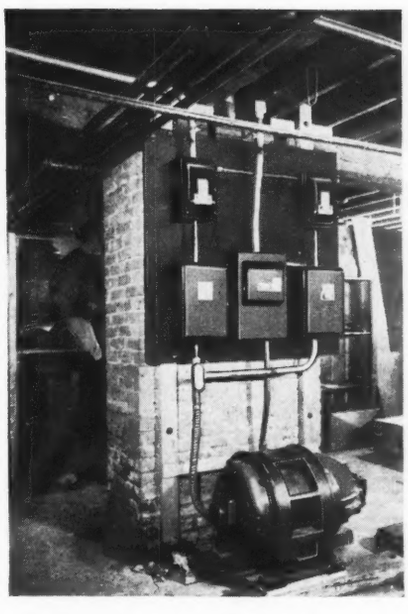
1. Burner in operation. Note cast-iron cap to plug air hole after burner removal. 2. Removing burner for cleaning. 3. Steam blow, here shown, is followed by water blow to complete cleaning

Oil-Burner Cleaning Rig

AT THE New England Confectionery Co plant, Cambridge, Mass., cleaning of mechanical oil burners firing power boilers used to be a problem. Burners had to be cooled, then soaked and scrubbed in kerosene. Then the kerosene had to be wiped off—a dirty time-wasting job! Now a cleaning fixture, rigged up by chief engineer S Peter Starratt, cleans burners in a couple of minutes with no mess or trouble.

Burner is unclamped from furnace fixture and reclamped in an identical holder, piped for steam and water and set above a slop sink to take the discharge. Opening steam valve (3) blows steam through burner, softening grease and blowing out carbon. After about one minute of steam blowing, steam is shut off and water valve is turned on. This cools the burner ready for handling—also completes washing.

Inspection of water spray at bottom shows whether burner is clean. If jet is "stringy", burner is given a second blow, first with steam and then with water. This particular rig uses 100-lb steam pressure, but higher or lower pressure will do the trick. FIELD EDITOR



Induction Motors Run 10,250 Rpm

SINCE JUNE, 1938, a dozen induction motors have been operating at 10,250 rpm in Geo E Keith Co's new Walk-Over Shoe Factory, Campello, Brockton, Mass. A similar system has been applied in certain other types of manufacturing operation (notably woodworking) for direct motor drive of high-speed spindles.

Photo shows the 7½-kw frequency changer converting 3-phase, 60-cycle, 350 volt to 3-phase, 180-cycle, 337-volt current. Output of this machine goes directly to the small induction, 3-phase, ball-bearing motors on the spindles of 12 shoe "edge trimmers." On 60 cycle, these motors would run at 3417 rpm. On 180 cycle they run 3 x 3417

= 10,250 rpm (full-load speed). To make such operation efficient electrically, each trimmer has its own capacitor to insure an over-all high pf.

Brockton, Mass. F W MOORE

Broken Roll Neck

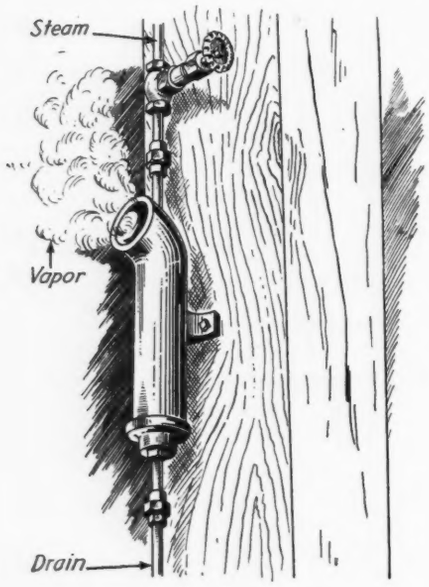
A PAPER machine was thrown out of operation by a broken roll neck. The machine could limp along without the roll, but not without the gear it carried, which meshed in the train of roll gears.

The gear from the broken roll was mounted on a solid shaft (having same diameter as roll neck). Inserted in place of original roll this maintained production until a permanent repair could be made. FIELD EDITOR

Air Moistener

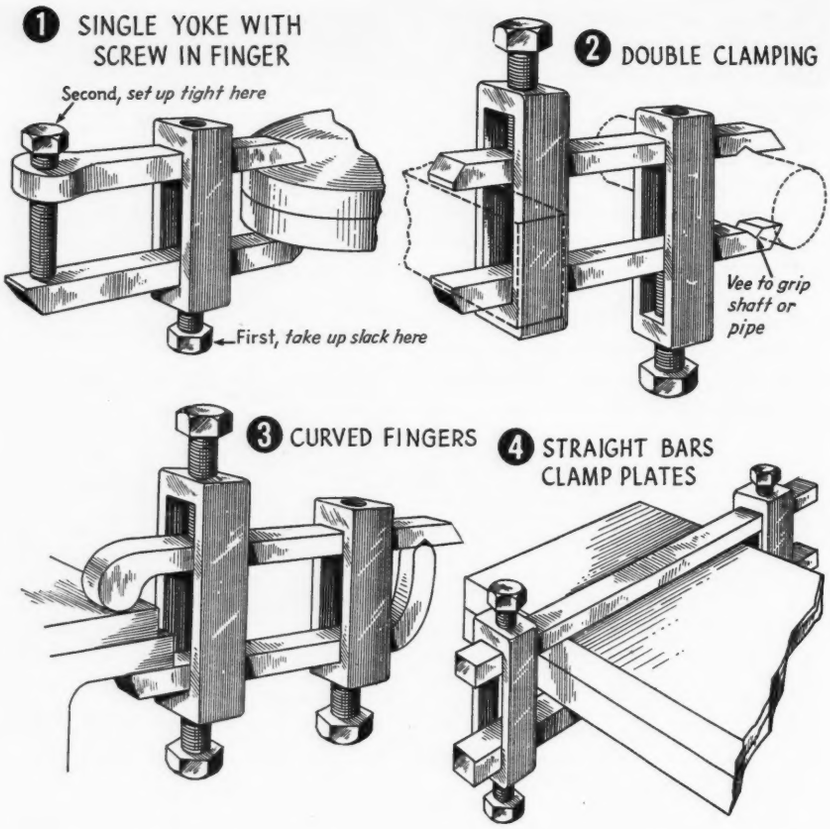
THERE IS nothing new about using steam to moisten factory air in dry weather to keep product in proper working condition. It is the simplest method, and gives close enough control for many applications.

Our maintenance force built and installed several moisteners like that shown to protect stocks in our sole-



leather room during dry winter weather. A local foundry cast the bodies from our pattern. Steam from low-pressure heating system, controlled by a hand valve, enters through ½-in. pipe above. Vapor discharges to room through large opening at top left. Condensate drains away through lower pipe. An equally good moistener could, of course, be made up from pipe fittings. Exact dimensions are not important.

Brockton, Mass. H A F CAMPBELL


1 SINGLE YOKE WITH SCREW IN FINGER
Second, set up tight here
First, take up slack here
2 DOUBLE CLAMPING
Vee to grip shaft or pipe
3 CURVED FINGERS
4 STRAIGHT BARS CLAMP PLATES

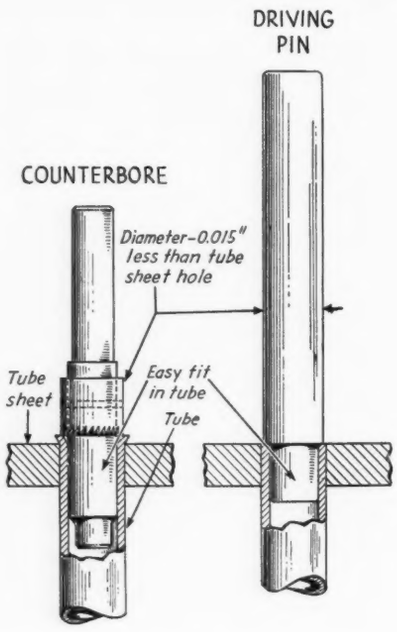
Yoke and Bar Clamps

I HAVE found the yoke and bar clamp so handy around the plant that I have sketched up a few of its uses for the old shop notebook.

The best size to make naturally depends on the sort of work handled in the particular plant. I made my yokes 6 in. long with a ⅝-in. opening. A finger with set screw (1) will give a powerful grip if yoke is moved close to work. Fig. 2 shows how two yokes and two fingers can be used for double clamping for example, as a temporary hanger from pipe or steel work. Fig. 3 is a sample of specially shaped fingers for special jobs.

Fig. 4 shows two yokes used with a couple of straight bars to hold plates together. Here use of two screws in each yoke avoids need for overly long screws. With at least 4 yokes and an assortment of fingers a good variety of jobs can be handled.

Penacook, N. H. C H WILLEY



Easy Way to Remove Condenser Tubes

MACHINIST F B Weslowski at New England Confectionery Co, Cambridge, Mass., has built a special set of tools for easy removal of admiralty tubes from a Carrene refrigerating condenser. These tubes (⅝-in. OD) are flared at both ends, projecting about ¼ in. from tube sheet. Problem was to cut off flared ends flush with sheet and then drive tubes out without damaging sheet. A demonstration, pictured on the cover of April POWER, was arranged with the cooperation of chief engineer S Peter Starratt.

Note that tits on both counterbore and driving pin are sized for easy fit inside tube. Outside diameter of body of driving pin is about 0.015 in. smaller than tube holes to avoid scoring holes

when driving tubes through the sheet.

Note also that counterbore shown in sketch does not correspond exactly with that now used. The sketch shows how Weslowski would shape his counterbore if he should make it over again. He would make the outside diameter 0.015 in. less than tube hole to avoid any possible damage to tube sheet.

FIELD EDITOR

Setting DC Brushes

POOR COMMUTATION of dc motors and generators is likely to develop if the different groups of brushes track alike on the commutator. Brushes set this way tend to wear grooves in the commutator. Then, any slight end movement of the commutator tends to force the ridges against the edges of the brushes, to lift them off the commutator and cause sparking.

To prevent this difficulty, brushes in one row should be set so that they track on the space between the brushes in the preceeding row. This will cause commutator surface to wear evenly.

Richmond, Va. C R ANDERSON

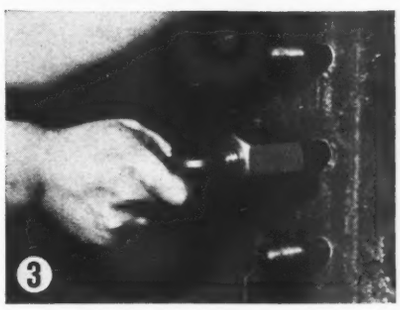
Stud Setter Won't Scar or Bind

WHEN A POWER editor recently visited the plant of New England Confectionery Co, Cambridge, Mass., Chief S Peter Starratt demonstrated a stud setter designed and built by his machinist, F B Weslowski, to avoid scarring studs with pipe wrench. Pictures show its use to set ¾-in. studs on the condenser shells of a centrifugal refrigeration system.

To make the setter, Weslowski took a piece of hex cold-rolled bar stock (1¼ in. thick between flats), chucked it in lathe and drilled a central hole about 2¾ in, deep and large enough to take a ¾-in., 10-thread tap. He then cut it off 2½ in. long and ran tap all way through.

Fig. 1 shows the resulting nut and ¾-in. x ¾-in. Allen set screw ready for insertion in threaded hole. This is screwed in far enough so that when nut is run on stud the set screw hits end of stud before hex nut reaches end of stud thread.

To use, screw nut on stud by hand. Then set up solid with ratchet wrench (2). To remove nut, first try to start it gently with wrench. If it binds, remove wrench and back off set screw half a turn (3). Then nut can be removed by hand. FIELD EDITOR



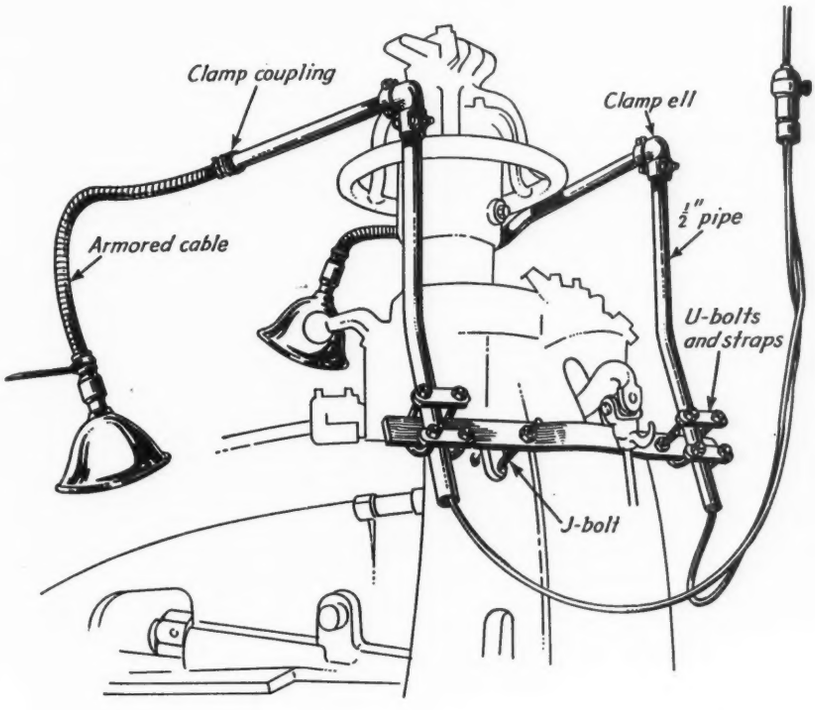
1. Long nut and set screw. 2. Set-up nut and stud ratchet wrench. 3. To remove nut, first back off set screw

Lighting Fixture Clamps on Machines

FOR PRECISION work it is often necessary to attach lighting fixtures directly to production machines. If the machine has no fitting for such a connection, and if it is not practicable to drill holes in the frame, lighting fixture can be assembled from iron strap, U bolts, J bolts, ½-in. pipe, clamp ells, clamp coupling and section of flexible armored cable, as shown here below.

Our own maintenance force built these fixtures and applied them to 12 "clicking" machines in our new shoe factory here. The assembly is mainly from standard fittings. Dimensions are not shown, because they must be changed for each application.

Brockton, Mass. F W MOORE



READERS' PROBLEMS

Questions for Our Readers

Need More Pressure

Question 1

IN OUR WORK *we need a constant water pressure of between 24 and 25 lb. We have a centrifugal double-suction pump taking water from a tank at suction level. When direct-connected to a 1000-rpm motor, the unit only produced 19 lb pressure, so we replaced the motor with one turning at 1600-rpm, which brought the pressure higher than we needed. We have tried throttling at the discharge valve, but at times we do not get the quantity we desire. The tank is in such a position that it cannot be raised. What can we do with this equipment to maintain the needed 24-25 lb?*—ED.

Drain Lines Clog

Question 2

WE HAVE *trouble with the drain lines of our humidifying system, which become clogged. These drains are from unit humidifiers in our weave room and we have heard of numerous other mills having the same trouble. Some evidence seems to point to algae as the cause, although it may come partly from gelatin used in sizing thread. Inasmuch as the mills referred to are all rayon-weaving mills it could not be any kind of lint. In appearance it is a gelatinous mass.*

Assuming that this formation is caused by algae, would the use of copper drain lines be of any help? We suppose that the answer to this might depend on the chemical analysis of the water supply, which is zeolite softened, with a pH between 8 and 9. What are other possible ways of attacking this problem?—GAS.

SUITABLE answers from readers will be paid for if space is available for publication. Answers accompanied by practical drawings or photographs will command additional pay.

Heating-System Pressure

Answers to April Question 1

The Question

Our job is to heat a 22-story building with a vacuum system. Boiler pressure is 100 lb, which is reduced to 40 lb at the main header, and further reduced to 2 lb between 3rd and 4th and 16th and 17th floors, feeding up and down from each place. Vacuum carried on the return side is 5 lb. We think that by reducing pressure at the main header to about 10 lb, using manually operated gate valves, we get lower coal consumption. Assuming the system is absolutely tight and perfect, which condition should be most economical? Why? Also, is there any recognized method by which the proper vacuum to carry can be determined?—HAD.

A Matter of Superheat

HOW CAN you reduce coal consumption by lowering steam pressure to 10 lb instead of to 40 lb? As the total reduction is from 100 lb to 2 lb, and it is done in two stages, it would appear at first sight that it would make no difference, yet there are reasons to doubt this.

The first thing to keep in mind is that reducing pressure in a valve superheats the steam. We don't want superheat at the radiators, but in some parts of the system it may do a lot of good. If most of the reduction takes place at the first reducing valve most of the superheat will appear at this point, and there will be considerably more superheat with a reduction of 100 lb to 10 lb, than with 100 lb to 40 lb.

If boiler steam is wet, steam should be practically dry in the header and if there is enough superheat, it will tend to dry the steam and reduce condensation in main risers. I don't know how much increased economy might be expected from this, but it is possible that under certain conditions it might be quite noticeable. That is probably what is happening in this case.

As to proper vacuum, standardized rules are generally misleading, except that it might be said the ideal vacuum is none at all. It takes a lot of power to produce a vacuum and anything more than the necessary minimum is wasteful.

Bloomfield, N. J. J O G GIBBONS

Cut and Try

ECONOMY of a vacuum heating system is due to use of heat at a lower-temperature level than would otherwise hold, thereby reducing line losses and sensible heat loss in condensate. For a given amount of required heating, a definite area of heating surface working at a definite temperature is necessary. If temperature is reduced, area must be increased.

Putting a steam system under vacuum lowers temperature in two ways. First, the steam is at a lower temperature, and second the quantity of steam flowing will be less because of its greater volume. If HAD has sufficient radiating surface and his piping is large enough, he may increase his vacuum to any practical limits, lowering initial pressures accordingly.

The saving HAD feels he is making by reducing the 40 lb to 10 lb is probably being realized through lower loss of heat from connecting piping and possibly by lowered pressure in the 2-lb main, which of course will lower steam consumption in the whole system.

Whereas proper vacuum to be carried could be calculated from building heating loss, radiating surface, pipe sizes, etc, HAD would be better off to cut and try until he finds the best vacuum and lowest pressure to maintain.

Saltville, Va. J C PORTER

Reduced Pressure Saves

HAD'S QUESTION can be answered definitely from a theoretical standpoint only by detailed calculations involving length and size of steam mains, quantity of steam used, effectiveness of insulation, and finally and most important, amount of moisture in steam at first throttling. The advantage of superheated steam over saturated, as considered here, is that superheated steam gives up heat to the wall of the pipe at a lower rate than saturated steam

of the same temperature, so there would be less loss of heat through radiation from pipe surfaces.

It is reasonable to assume that steam in HAD's plant contains at least 2% moisture at the first throttling point, a hand-controlled gate valve. When throttled to 40 lb there would still be some moisture, but if throttled to 10 lb it is probable that moisture in the 100-lb steam would be evaporated and we should have 10-lb steam slightly superheated. Loss in radiation would be less in that part of the system between main header and distribution points on the 3rd and 16th floors, if steam were reduced to 10 lb. This difference in radiation loss would be further increased because 10-lb steam, even slightly superheated, would have a lower temperature than 40-lb steam. In this case theory and practice seem to be in accord, as HAD states that when operating at lower pressure, coal consumption seems somewhat reduced.

As to the proper vacuum to be carried in the return lines, there is little to be said for any particular vacuum if all the condensate is returned to the boilers. Assuming thermostatic traps on the radiators, they must be adjusted to discharge condensate at about 188 F in order to maintain a vacuum of 5 lb, which corresponds to close to 10 in. of mercury. Setting these traps for higher temperature would mean reduced vacuum but hotter water returned to the boilers, and if radiators are sufficiently generous, it would be an advantage to maintain vacuum as high as possible, and return the condensate at as low temperature as possible. Here again we should have less loss due to radiation because of lower temperature.

Considering that the principal dimension in this system is probably the vertical, there is no necessity for a high vacuum in order to get the water back to the boilers. In a large industrial plant heated by exhaust steam at 5 lb gage, the principal dimension of the system was horizontal, and 15 in. of vacuum was found ample for return of condensate to the pumps by which it was delivered to the boiler.

Pottstown, Pa. T HOLTZ

Install Reducing Valves

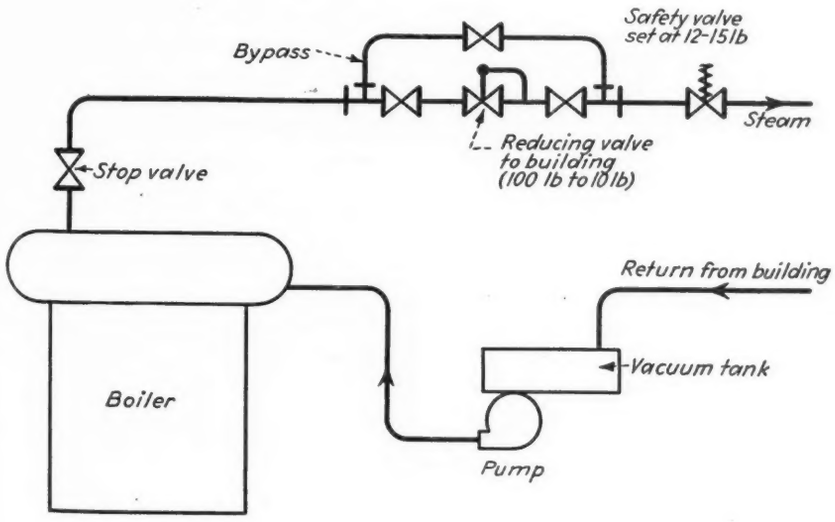
IF 40-LB PRESSURE is held in the piping of HAD's system, it will produce greater heat losses due to the length of the piping, than would be the case with 10 lb; therefore, the latter should produce a fuel saving.

Best results may be had by installing pressure-reducing valves on main outlets to the building with suitable bypass lines and valves. The valves would be set at 10 lb. Reducing valves would be more economical than operating boiler stop valves by hand, as this causes wire drawing of the steam and a subsequent loss in heat value of the steam due to its expansion from the throttling action of the hand-operated valve.

On the main outlet to the building, fit a safety valve set at 12 or 15 lb, the valve having the same size as the outlet main. Safety valves will prevent serious accident in case of failure of the reducing valve.

If the system is tight and free from leakage, and maintenance of vacuum pump or pumps and their attachments is good, there is no reason why 10-lb pressure and 5-lb vacuum will not heat the building. To compute the vacuum required, the writer suggests referring to Warren Webster's "Steam Heating", or some other book on heating.

Grand Rapids, Mich. J M GORRIE



Check Steam Quality

APPARENTLY there is a great deal of moisture in HAD's steam and reducing pressure from 100 to 10 lb will superheat steam to a greater degree than going from 100 to 40 lb. I suggest HAD make a check on moisture content of steam leaving the boiler. Incidentally, this should not be interpreted as an indication that superheated steam is superior to saturated steam for heating purposes, because it is not.

Vacuum carried should be just enough to insure prompt removal of air and water from radiators, and to lower initial pressure. Ordinarily 2 in. is carried at most distant radiators which may require from 3 to 20 in. at the pump depending on the length of the returns. As an average, probably 8 to 10 in. will be sufficient.

Cleveland, Ohio F W NEUBRANDER

Oil in Boiler Water

Answers to April Question 2

The Question

WE HAVE *two 3500-sq-ft Stirling boilers, one 550-hp and one 200-hp engine, a steam-driven air compressor, and the usual auxiliaries. Engines exhaust to a 12-in. line supplying the building-heating system and connected for atmospheric exhaust when not heating or when backpressure exceeds 5 lb. The 12-in. line has two oil separators, one at each end of the engine room. Drainers are also provided, and are inspected daily to insure proper operation. The open exhaust heater also has an oil trap which is working.*

Every winter we are troubled with oil in the water supply which is carried to the boilers. The insurance inspector says we should have an oil extractor in the water lines, as the separators and drainers will not eliminate all oil from the exhaust steam. Engineers claim that if the separators and drainers are working properly, they will eliminate all oil. We have all lubricators cut down as low as possible, and we inspect engine valves monthly, for lubrication and wear. Should separators and drainers take care of all oil, and what might be the reason for oil getting into the water supply? What is the remedy? —MEF

Remove Oil

PULSATIONS from engine exhaust, particularly the larger cylinders, result in excessive instantaneous velocities through separators. The fact that the

insurance inspector finds oil in the boilers indicates that means of oil removal are not effective. Removal of oily vapor from low-pressure steam is difficult even with the best equipment.

Removal of oil from condensate is the next step. This is rendered increasingly difficult as oil manufacturers compound cylinder oils to give increased emulsibility. Straight gravity separation is not dependable as these emulsions fail to separate by simple gravity differential.

A new method, coming into greater use, is to remove oil from condensate by filtering through beds of fine emulsion-breaking material, such as prepared lignite. Surface action of grains breaks the emulsion and causes oil to collect in particles that can be steamed and backwashed out of the filter. Use of sand or anthracite filters, together with proper coagulants to give a floc that will trap the oil, may also serve to clear up oily condensate. Difficulties of this system are: (1) surge tanks needed to smooth out pulsating return without waste of water, (2) mixing and proportioning of coagulants must be adjusted and controlled by chemical tests, otherwise unreacted coagulants go through filters to give "after precipitation".

Fargo, N. Dakota LAWRENCE KIRK

Make Thorough Check

FIRST THING for MEF to do is examine engine oil separators in exhaust lines to determine condition. The internal baffle, if any, will probably be heavily coated with carbonized oil or the baffle may be defective, allowing particles of carbonized oil and globules of good oil to pass to the open heater. Separators should be renewed if defective.

Oil separators with attached traps should be inspected next, especially the traps which may have become inoperative due to oily sludge adhering to walls, causing floats to stick. Traps should be cleaned and if found defective should be renewed.

Next on the inspection list is the open heater—the most important item. There will probably be an oily sludge adhering to inner surfaces of heater walls and also on trays. Trays should be removed and scraped, and walls should be brushed down with a caustic solution to remove traces of oil. Filter bed in the heater, if any, should be attended to, as it is probably dirty. It has been found that a filter bed of layers of coke and limestone chips will reduce the possibility of oil entering the boiler, provided the filtering medium is periodically inspected and washed. First layer of coke should be placed on separator tray at bottom of heater and be from 8 to 10 in. thick, the next layer of limestone chips should be of the same thickness, and, if there is room, another layer of coke will help. Coke and limestone chips should be of best "foundry" type.

If boilers become coated with oil, boiling out with a solution of caustic soda and soda ash will remove coating. Leave steam connections open to atmosphere, fill boilers to within 8 in. of top of uppermost drum. After boiling out, drain and clean out sludge in drums.

Grand Rapids, Mich. J M GORRIE

Suggests Filter

There is no question as to the soundness of the boiler inspector's advice. Oil separators do not remove all oil from steam, and manufacturers do not claim 100% efficiency for their products, but oil separators do a wonderful job when the proper grade of oil for existing steam conditions is used. Oil separator action can be improved by installing an atomizing water spray in front of grids at inlet side. This has effect of aiding impingement of oil on grids, providing velocity through the separator is not too great. In the open heater, if flow of feedwater is not fairly uniform and heater is taxed to capacity at times, oil trap will be overloaded and will not work.

I certainly second the inspector's suggestion and recommend an extractor using terry-cloth filter bags. Installing duplicate units of ample capacity should cure the trouble once the boilers are cleaned. We had similar trouble and bought filters of this type, and since that time we have had no oil in the boilers. One filter is used at a time. We have enough spare sets of filter bags to insure clean filters at all times and we run a filter 12 hr before changing.

One other thing MEF should do is consult an unbiased lubricating engineer to make sure that proper oil is used. It may be that an oil that does not emulsify so easily and will separate quicker should be used.

Dorchester, Mass. W F O'REGAN

May Be Operation

IN A VACUUM-HEATING SYSTEM, during periods of light load or when exhaust steam supply falls below demands of heating system, pressure in exhaust line will fall below atmospheric and will show a vacuum depending on vacuum carried at the pump, line loss, and other factors. If oil traps are installed for non-condensing operation only, they will cease to function and oil will be retained in exhaust and carried through the heating system and to the boiler. If this is the case, traps should be installed so they will function either above or below atmospheric, keeping exhaust clear at all times. Methods of connecting traps to exhaust lines for pressures above or below atmospheric were thoroughly discussed in POWER, April 17, 1926.

If the above condition exists it will also be observed that the feedwater heater fails to work, either as a deaerator or as a heater. The most practical solution is to install a valve in the line to the heating system so that pressure in the exhaust line and heater will always be above atmospheric, allowing only surplus steam to go to the heating system. Further notes on valves for this purpose can be found in POWER, November 1936, and September 1938.

Rochester, N. Y. JULIUS BRODSKY

Oil May Be at Fault

ONE DIFFICULTY may be use of compounded cylinder oil, which will emulsify with water and can be removed only by longer settling than is possible in the power-plant cycle. Remedies may lie in use of straight mineral oil and in reduction of supply to minimum needed for correct lubrication.

Schuyler, Neb. RUDOLPH URBA

Heater Is Trouble Point

The open heater is the focal point of MEF's trouble. If it is too small any oil trap will be ineffective because of lack of time for stratification. Excessive turbulence caused by entering exhaust will also hinder oil removal. Here, too, oil trapped off with condensate at the engines may return to the system via the hotwell. It may be that one or more steam traps, used on the exhaust line only under the higher backpressure in winter, are trapping off a quantity of oil which reaches the boilers by this method, in effect, short-circuiting the oil separators. Any steam trap on an engine or exhaust line which seats badly will allow oil to pass through in the blowby.

Simplest remedy is the oil extractor suggested by the insurance inspector. A check on the heater should be made, for if feedwater is drawn from it while in an excessively turbulent state, the best oil trap available will be ineffective. The two separators would probably remove more oil if arranged in parallel instead of series.

Menard, Ill. MARVIN WHITE

ARGUMENT CORNER

Engineer's Swan Song

THIS LITTLE STORY is written by one whose business requires him to call on power plants, large and small, over a wide area of this country. On Monday morning I visit the Jones Company's plant which has an average boiler plant with three oil-fired hrt boilers. The Chief, Mr Smith, comes forward importantly. After introductions are over, he starts the conversation in earnest. While we are walking around he goes on like this:

"You should have seen this place when I came here. Why, things were in awful shape. There was coal dust and dirt everywhere. Now look at it! (99% credit to Mr Smith, and 1% for a changed installation).

Tuesday, I enter a paper mill having several watertube boilers. Mr Worthington is the engineer in charge. As a boiler is opened up for inspection, we look into the tube ends. A light scale adheres to the tubes.

"Why", says Mr Worthington, "when I came here, those tubes were choked with scale. We couldn't even get a turbine into them. Just see how clean I've got them!"

Then comes Wednesday morning. A visit to a textile mill brings forth the Chief, Mr Arthur. Again the old story. "You should have seen this plant when I started here! You just can't picture it from the way it looks now." I did this, I did that, I changed this, I fixed that, etc., etc.

Again, again, and again, it comes—the Engineer's Swan Song. Can't these fellows realize that if a plant shows exceptionally good care and presents a fine appearance, that any visiting engineer of at least moderate intelligence will recognize the fact and give due credit. Nothing is gained in telling how poorly your predecessor took care of things, especially when he isn't there to defend himself. A little modesty is sometimes of as much virtue as blowing your own horn too loudly.

Mr Engineer, are you one who sings that **! swan song to every visitor?

Chicago, Ill. CHARLES ARMSTRONG

* *! Swan Song (Armstrong)

Are We Engineers? An Oiler Says No

FROM TIME to time controversies have arisen between technically trained engineers and power-plant operating men over the use of the title "engineer". Both groups are proud to use the term and are jealous of others whom they feel are not entitled to do so.

The college men feel that because of their superior knowledge and the time, energy, and money expended in securing it, only they should be called "engineers". The other group, composed of stationary, marine, and locomotive engineers, feel that because of their prior use of the term they too should enjoy all the distinctions that the title implies.

This question has gone so far that in some states legislation has been introduced to forbid practical men calling themselves engineers, and the other group has tried to gain for operating men the granting of professional engineers licenses after ten years service.

Going on the assumption that the rights of the men should be proportional to their merits, let us examine a typical cross-section of operating engineers. The writer of this article is himself an oiler in a large central station.

Once, while visiting a municipal heating and electric plant, I asked the engineer in charge the capacity of his engine-driven dc generators. The answer was "800 Amperes". This man did not realize that amperage means nothing unless the voltage is specified and that his answer should have been in kilowatts. Later he informed me that he had been an engineer for 50 years. Evidently he had not learned anything for the past 40!

An engineer in a Southern utility plant, who was talking about the old days, told me of a turbine which for some mysterious reason would carry only 60% of normal load because, as was found later, all of the blades were stripped from the wheels. I asked him if there were not a few blades left and he said, "No, none at all". I said that it must be a pretty good turbine to carry even 60% of full load with no blades. Imagine what it could do if a few dozen buckets were left intact!

During a visit to a midwestern central station, somebody mentioned tandem-compound turbines to the watch engineer. He said that there were none in his plant. But as a matter of fact, there were two units of this type which had been in operation for 20 years.

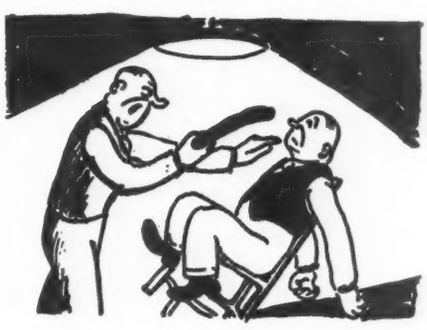
On glancing over the instrument panel of one of the largest high-pressure boilers in the country, I noticed that because of a discrepancy in the meters, steam flow was 10,000 lb per hour less than the feedwater flow. The fireman explained that he had to put in the additional water to "kill the steam". Figure that one out! This man had been picked from a large group to operate the 1400-lb boiler, but he did not know that if you put more water into a closed vessel than you take out of it, the vessel will fill up.

These examples were not supplied by men operating a little back-woods saw mill. On the contrary, the engineers and oilers mentioned are almost all licensed and are employed in civil service jobs, on large steamships, and in utility plants.

The solution for this state of affairs is to make license examinations much harder than they are at present, and for plant managers to require not only a State license, but also the passing of a difficult examination covering principles and practices in the individual plants. If promotions and salary increases were granted on a merit basis, instead of counting so much on the fallacy that experience is necessarily valuable, operating engineers would soon increase their efficiency.

Jersey City, N. J. LEE MACKEY

What's an Engineer (Mackey)



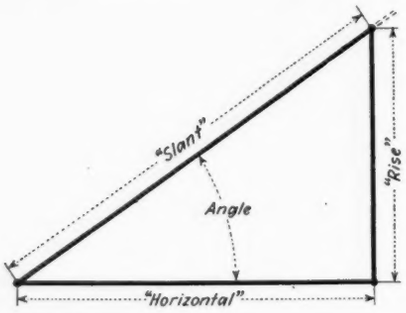
I Believe in Sines

by Phil Swain

I BELIEVE IN SINES—also in tangents, cotangents and cosines. I believe that every practical engineer should have these mental tools in his kit to measure and lay out angles. This is the most useful thing in trigonometry—also the easiest to learn.

First learn these abbreviations: sin (sine); tan (tangent); cot (cotangent); cos (cosine); deg (degrees). Mathematicians call sine, tangent, etc the "functions" of angles.

The table of "functions" shown here is complete enough for practice and for many actual problems. For further use, any engineering handbook will give the "functions" for every minute of angle from zero to ninety deg, and



1. Definitions:
Sine = "rise" ÷ "slant"
tangent = "rise" ÷ "horizontal"
cotang. = "horizontal" ÷ "rise"
cosine = "horizontal" ÷ "slant"

for more decimal places than shown here.

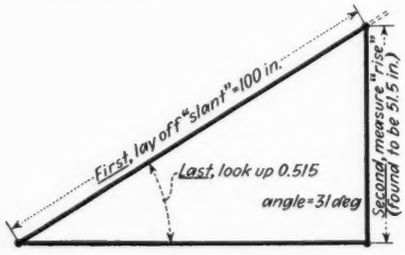
For angles from zero to 45 deg, read the angle in the *left* column and go by the headings at the *top*. For angles from 45 deg to 90 deg, read the angle in the *right* column and go by the column names at the *bottom*. To make sure you understand this, check the following against the table:

sin 11 deg (sine of 11 degrees) = 0.191
cot 25 deg = 2.145
cos 46 deg = 0.695
tan 65 deg = 2.145
cos 79 deg = 0.191

We now know how to read the abbreviations and use the table. Next step is to understand what sine, tangent, cosine and cotangent are. To make this easy, start by measuring all angles from a horizontal line. Think of the upper side of the angle as the slope of a roof. Measure any distance up this line and call it the "slant". Then you have the corresponding "rise" and "horizontal", as shown in Fig. 1, and the definitions there given.

Now for a practical application: You have only a tape measure and wish to measure the slope of a duct in degrees, using the sine. Lay off 100 in. on the slant. Next, measure the corresponding rise. Let's say the rise is 51.5 in. (Fig 2). Then the rise divided by the slant is 0.515, which must be the sine, by the definition in Fig 1. Look up this sine in the table and you find that the roof slopes 31 deg.

Often it is more convenient to lay off the 100 in. on the horizontal. If you do this for the same duct, you will find the rise is 60.1 in. Then the rise, divided by the horizontal is 0.601, which must be the tangent by definition in Fig. 1. Look up 0.601 in the tangent column and you again find that the slope is 31 deg.

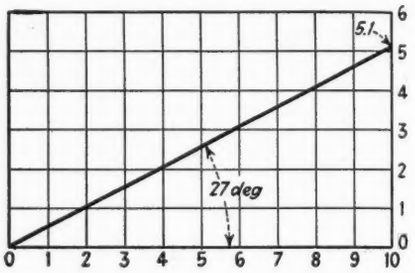


2. Measuring duct slope by sine

To *lay out* angles by length measurements, merely turn this process around. To lay out a slope of 31 deg by the tangent, lay off a horizontal of 100 in. and rise of 60.1 in.

Fig 3 shows how easy it is to lay out 27 deg without a protractor if you have squared paper divided into tenths.

Theoretically, sine and tangent will handle all your problems, but they are not accurate for laying out or measuring angles close to 90 deg (say from 60 deg up). In general, use sine and



3. Laying out 27 deg by tangent

tangents for angles up to about 45 deg. Use cosines and cotangents, generally, for angles from 45 deg to 90 deg. To lay out 85 deg by cotangent, lay off a rise of 100 units and a horizontal of 8.7 units (cot 85 deg is 0.087)

Power-plant applications include laying out (or measuring) angles of piping, conveyors, bunker bottoms, etc.

"FUNCTIONS" OF ANGLES

Read degrees on left Deg	Sin	Tan	Cot	Cos	
0	0.000	0.000	infinity	1.000	90
1	0.017	0.017	57.290	1.000	89
2	0.035	0.035	28.636	0.999	88
3	0.052	0.052	19.081	0.999	87
4	0.070	0.070	14.301	0.998	86
5	0.087	0.087	11.430	0.996	85
6	0.105	0.105	9.514	0.995	84
7	0.112	0.123	8.144	0.993	83
8	0.139	0.141	7.115	0.990	82
9	0.156	0.158	6.314	0.988	81
10	0.174	0.176	5.671	0.985	80
11	0.191	0.194	5.145	0.982	79
12	0.208	0.213	4.705	0.978	78
13	0.225	0.231	4.331	0.974	77
14	0.242	0.249	4.011	0.970	76
15	0.259	0.268	3.732	0.966	75
16	0.276	0.287	3.487	0.961	74
17	0.292	0.306	3.271	0.956	73
18	0.309	0.325	3.078	0.591	72
19	0.326	0.344	2.904	0.946	71
20	0.342	0.364	2.747	0.940	70
21	0.358	0.384	2.605	0.934	69
22	0.375	0.404	2.475	0.927	68
23	0.391	0.424	2.356	0.921	67
24	0.407	0.445	2.246	0.914	66
25	0.423	0.466	2.145	0.906	65
26	0.438	0.488	2.050	0.899	64
27	0.454	0.510	1.963	0.891	63
28	0.469	0.532	1.881	0.883	62
29	0.485	0.554	1.804	0.875	61
30	0.500	0.577	1.732	0.866	60
31	0.515	0.601	1.664	0.857	59
32	0.530	0.625	1.600	0.848	58
33	0.545	0.649	1.540	0.839	57
34	0.559	0.675	1.483	0.829	56
35	0.574	0.700	1.428	0.819	55
36	0.588	0.727	1.376	0.809	54
37	0.602	0.754	1.327	0.799	53
38	0.616	0.781	1.280	0.788	52
39	0.629	0.810	1.235	0.777	51
40	0.643	0.839	1.192	0.766	50
41	0.656	0.869	1.150	0.755	49
42	0.669	0.900	1.111	0.743	48
43	0.682	0.933	1.072	0.731	47
44	0.695	0.966	1.036	0.719	46
45	0.707	1.000	1.000	0.707	45
	Cos	Cot	Tan	Sin	Deg

Read degrees on right

Firetube Boilers

by Harry Spring

Q.—How would you prepare a boiler for inspection?

A.—Extinguish fire and allow boiler to cool slowly. When it is cool, open blowdown and drain, venting boiler to atmosphere. Then blow and sweep soot and ashes clear of all tubes, shell plates, heads, seams, and every accessible external surface.

Shut blowdown valve if any other boilers feed this line. Then remove manhole and handhole plates. Wash out loose deposits of sludge or other sediment. The blowdown valve should be opened only when you are positive that there is no pressure in the line, and when no one is inside the boiler. Leave attached scale or oil deposits for inspector to see. A boiler properly prepared for inspection should be COOL, CLEAN AND DRY.

For safety, keep red tags marked "MAN IN BOILER" attached to the steam, blowdown, feed and fuel valves, and also on the manhole plate at all times when any one is in the boiler.

Q.—How are diagonal stays installed?

A.—When the crowfoot is in position against the head, the holes in the shell should be so located that holes in the palm of the stay are about 3/32 in. shy of lining up. Often crowfoot is bolted to head, and shell is marked for palm holes, then drilled to meet this requirement.

Then rivet crowfoot to head and elongate stay until shell and palm holes line up. This is best done by heating, but a drift pin is often sledged in one shell hole to serve the same purpose. The palm is riveted in position; the stay is then in tension to support the head.

This is done before tubes are installed; tube sheet must be kept from buckling by a strong-back until tubes are in.

Q.—May a safety-valve nozzle or steam nozzle be welded to boiler shell?

A.—Yes, if the requirements for fusion welding are met.

Q.—Briefly, what are these requirements?

A.—Welders must be certified. Joints must be stress relieved, examined by X-Ray or Gamma ray and given a hydrostatic and hammer test by an authorized inspector. (X-Ray examination not required on some nozzle designs).

Q.—How should a dome be attached to boiler shell?

A.—If the dome is 24 in. diameter or over, it should be double riveted or double full-fillet welded. If under 24 in. diameter, it should be double full-fillet welded, or single riveted unless dome diameter times maximum pressure (lb per sq in.) exceeds 4000. Double riveting is then required. If the double full-fillet welding is used, weld must meet all specifications for fusion welding, except that X-ray examination may be omitted.

Q.—Where and why are drain holes required in a steam-dome installation?

A.—A drain is required on each side of the dome in the lowest part of the neutral sheet so that condensate will not collect and possibly cause corrosion.

Q.—What precautions would you take before entering a boiler shell?

A.—If blowdown enters a common line, with other boilers in operation, be sure all valves on line to open boiler are closed. If other boilers are operating on the same steam header, be sure *both* stop valves are closed and drip valve between them is open. Check any other valves on lines under pressure leading to the boiler.

Tell the engineer in charge, and the operator on duty, that you are going inside. Have a responsible person stationed at the manhole while you are inside.

Q.—What does an inspector do in following construction of a boiler through the shop?

A.—On first visit he checks chemical and physical properties of steel from mill-test reports to see if they meet Code requirements. He then checks melt and slab numbers on these reports with numbers stamped on plates.

He checks shop's standing to see that it is authorized to construct boilers for the state in which boiler is to be installed. He examines plates for any visible defects (scars, gouges, laminations, etc.) He gages plate thickness, allowing a tolerance of .010 in. under that specified. He checks design of proposed boiler to see that it meets Code specifications.

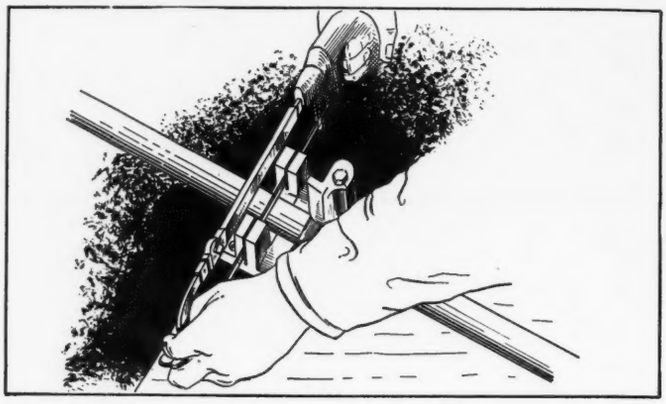
He makes a second visit to check methods used for riveting or welding, preparing caulking edges, rivet holes, tube holes, and assembling the boiler. On completion, he makes a third visit to view the hydrostatic test, examine general workmanship. If boiler has been completed satisfactorily in accordance with Code specifications, the inspector stamps it and signs the manufacturer's data sheets.

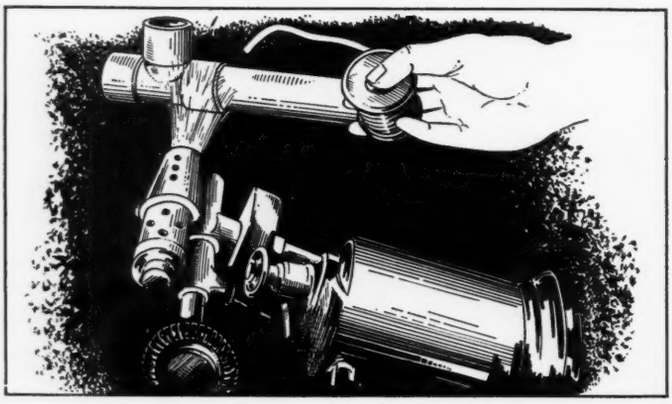
HOW TO ASSEMBLE SOLDER-TYPE FITTINGS

[Based on information appearing in "Anaconda Copper Tubes & Fittings for Heating Lines", published by American Brass Co.]

1 →

CUT TUBE SQUARE with hack saw (92 teeth per in.). If possible, use special tube vise (won't distort) with saw-blade guide. Remove inside and outside burrs with triangular scraper and 8- or 10-in. half-round mill file. Then use steel wool or emery-cloth to clean mating surfaces of tube and fitting, making certain all discoloration is removed (very important). Use tooth brush to apply thin, uniform coating of flux over entire area of mating surfaces and insert tube as far as it will go.



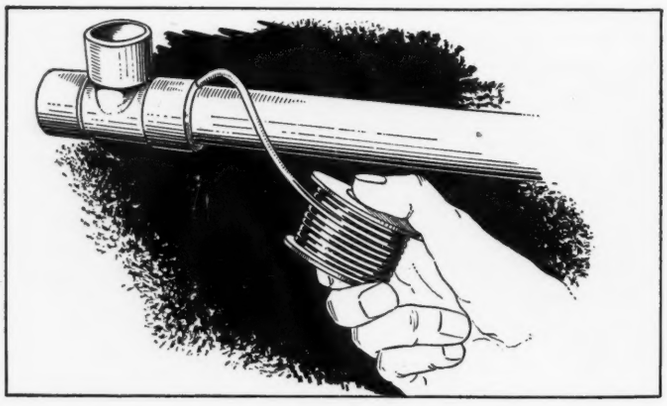


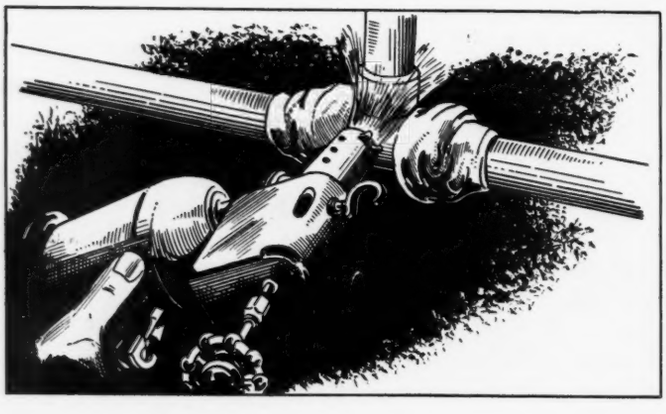
2 ←

HEAT WITH A GASOLINE or an air-acetylene torch. (Latter is faster and more convenient; flame is more concentrated, better controlled.) A small portable acetylene tank will contain enough gas for scores of small joints. Apply flame to fitting, not tube, testing heat occasionally by touching fitting with solder. Flux will start boiling out of joint when sweating temperature is approached.

3 →

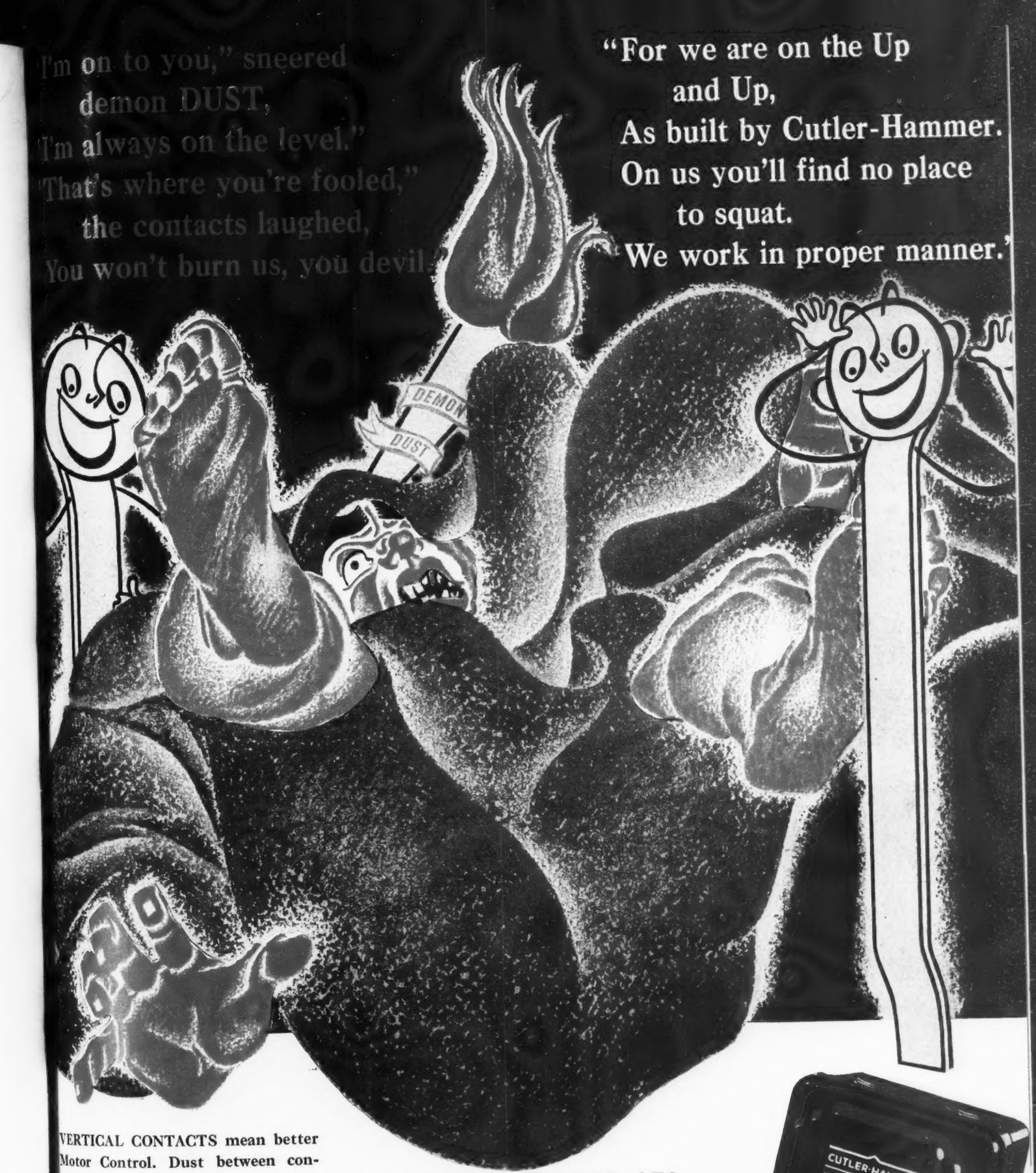
WHEN FITTING IS HOT enough to melt solder, remove flame and apply solder to fitting edge where it contacts tube. Use enough solder. Amount can be measured by kinking solder wire (⅛-in. solid wire, *not* flux filled) a distance from end equalling tube diameter. When solder congeals to plastic state, remove excess metal with cloth or brush, leaving fillet of solder in chamber at end of fitting. Note: Step 3 can, of course, be omitted, where fittings containing solder are used.





4 ←

IN MAKING SUBSEQUENT CONNECTIONS to same fitting, wrap previous connections with wet cloth to prevent remelting. *Note for Large Joints.* Use special care with fittings 2½ in. and larger. Keep flame on fitting to avoid annealing the tube. Keep it moving around to insure uniform heating of entire circumference. With air-acetylene equipment, use a tip giving a wide flame. For assembling lines 3 in. and over, two or three torches may be needed. Solder should then be applied simultaneously at two or more points.



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Power Lines

Editor Invites Suggestions For West-Coast Trip

I am now planning the details of a one-man power pilgrimage up the Pacific Coast from Los Angeles to Seattle. My purpose is to get better acquainted with POWER readers on the Coast, to make new contacts and to gather editorial material. While my exact itinerary has not yet been determined, I expect to reach the following cities on these dates, approximately:

Denver	June 19
Salt Lake City	June 20
Los Angeles	June 24
San Francisco	July 1
Portland	July 15
Seattle	July 20
New York	Aug 1

On the way out to Los Angeles I plan to stop off at Boulder Dam. In San Francisco, I shall, of course, visit the Fair and attend the Semi Annual ASME meeting (July 10-15).

Yet none of these is the primary object of my trip. What I want to do, more than anything else, is to get in closer touch with a lot of typical engineers and typical plants. I shall therefore greatly appreciate receiving suggestions from readers on the Coast: tips about engineers who are doing interesting things; plants (large and small) worth seeing; good examples of steam, hydro, and diesel plants or of air conditioning and other power services.

Naturally it won't be possible to follow all suggestions received, but a good assortment will help me make this trip more serviceable to all POWER readers, East and West.—PHILIP W SWAIN, *Editor*

Oil and Gas Engineers to Meet at Ann Arbor

This year the Oil and Gas Power Division of the ASME is to hold its national meeting at the University of Michigan, Ann Arbor, Mich., June 19 to 22.

The program covers five sessions at which papers will be presented and one afternoon session which will be given over to inspection trips or entertainment. Fourteen papers are scheduled and in addition an oral discussion on the development of General Motors Diesels and their future. F G Shoemaker of the General Motors Detroit Division will give this talk before the inspection of the company's Diesel plant.

The program follows:

Monday, June 19

2:00 p.m.

Oil- and Gas-Engine Practice in Great Britain, by A K Bruce, London, England

Résumé of European Design of Internal-Combustion Engines, by M Bochet, Paris, France

High-Speed Diesel Engine Development in U. S., by C G A Rosen, Caterpillar Tractor Co.

Tuesday, June 20

9.00 a.m.

Joint Use of Diesel Engines and Utility Power, by Edgar J Kates, New York, N. Y.

Where Does Interpretation Begin?—Analysis of Oil-Engine Power Cost Report, by P H Schweitzer, The Pennsylvania State College

2.00 p.m.

Symposium on Piston-Ring Troubles: Introductory remarks and discussions led by H L Koehler, University of Michigan

(1) Factors Affecting Design and Materials, by J M Dodge, Double Seal Ring Co

(2) Wear of Diesel-Engine Cylinders and Rings, by Paul S Lane, American Hammered Piston Ring Co

(3) Practical Service Conditions, by D D Cook, Cooktite Ring Sales Co

(4) Rings From Users Standpoint, by Stuart Nixon, Sealed Power Corp

Wednesday, June 21

9.00 a.m.

Stability of Crank Case Oils, by Walter F Weiland, University of Nebraska

Operation of Lubricating Oil Systems, by Paul Williams, Skinner Purifiers, Inc.

Discussion: Development of G M Two-Cycle, High-Speed Diesels and Their Future, led by F G Shoemaker, General Motors Diesel Division

Afternoon

Trip to plant of General Motors Diesel Division

Trip through Greenfield Village

Entertainment as arranged by U of Michigan

8.00 p.m.

Banquet and entertainment

Speakers to be arranged. Talk will be given on "War Department: Diesels for National Defense," or there will be moving pictures with talk concerning "Diesels in Railroad Service"

Thursday, June 22

9.00 a.m.

Interpretation of Smoky Exhaust of Diesel Engines, by H E Degler, University of Texas

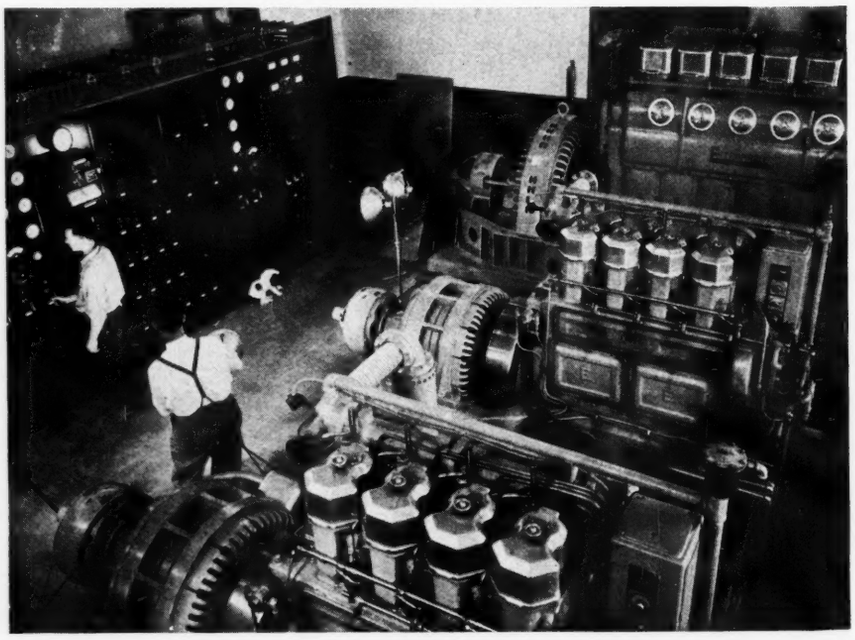
Characteristics and Development of Combustion Chambers of American High-Speed Compression-Ignition Oil Engines, by V L Maleev, Oklahoma Agriculture & Mechanical College

Injection Systems for Oil Engines, by E T Vincent, University of Michigan.

New Plant for Allis-Chalmers

Contracts have been let to build a new transformer plant in Pittsburgh, to be known as the River Plant of the Allis-Chalmers Mfg Co, Pittsburgh Works. The plant will be 416 by 144 feet; will cost, with buildings and equipment, about $378,000; and will be put into operation about August 15.

In design, this plant will represent the



POWER FOR THE SEEING EYE

With little work left to be done on the huge Mt Palomar Observatory, near Pasadena, Calif., scientists are awaiting completion of the grinding of the 200-in. lens for the world's largest telescope. The observatory's power plant, finished this spring, contains three Enterprise Engine Co diesels; two are 120-hp, 600-rpm, 4-cyl, 8x10-in, units—the third is a 225-hp, 450-rpm, 6-cyl, 10x13-in. engine (Acme Photo)

Choice of Many Leading Hotels, Hospitals, Public Buildings

for

- WATER HEATERS
- KITCHEN EQUIPMENT
- STERILIZERS
- LAUNDRY MACHINES
- AIR CONDITIONERS
- UNIT HEATERS
- STEAM MAINS
- POWER PLANTS

The Henry Grady Hotel, Atlanta, is another enthusiastic Yarway Steam Trap User

More than 50 thousand Yarway Impulse Steam Traps are in use today—many installed in large buildings of all kinds including leading hotels and hotel chains; hospitals and institutions; Federal, State and Municipal Buildings and central heating plants.

Why have architects, heating engineers, contractors and building operators "swung to Yarway" in so many cases where higher steam pressures are involved?

Rugged, dependable throughout their long life—they end many trap maintenance troubles. Small size, light weight—they take less room, make installation easy. Highly efficient—they get equipment hotter, sooner. Good for various pressures without change in valve or seat. Low in price—they usually cost less to buy than to repair other type traps.

Try Yarways and find out how they save trouble and expense. Ask your supply house—or write for Catalog T-1734.

YARNALL-WARING CO., 100 Mermaid Ave., Philadelphia

YARWAY IMPULSE STEAM TRAP

latest manufacturing methods as applied to the production of distribution transformers. It will be set up on a line production basis—raw material coming in at one end and a finished product going out at the other—and it will generally increase efficiency as applied to production of this product.

The general contractor awarded this job is H M Siesel Construction Co, of Milwaukee and Pittsburgh. Contracts for the steel work went to Bethlehem Steel Corp.

"Spring Round-Up" Corrals 700 Engineers

More than 700 members of ASME's Metro Section got caught in the "Spring Round-up," held April 20, in New York, N. Y. This different variation on past President's Night dinners started in the afternoon with a series of short and snappy technical sessions in which developments in each field of mechanical engineering were highlighted by outstanding men, and continued through a cocktail hour, dinner, and an evening's entertainment.

The guest of honor, President A G Christie, gave a brief talk on "The Engineering Way Out" in which he outlined a program for increasing national social and economic well being. J Schuyler Casey, M H Treadwell Co, acting as toastmaster, then introduced Dunninger, whose feats of magic and mind reading had what should have been a hardboiled audience sitting on the edge of their chairs.

Newcomen Society Meets

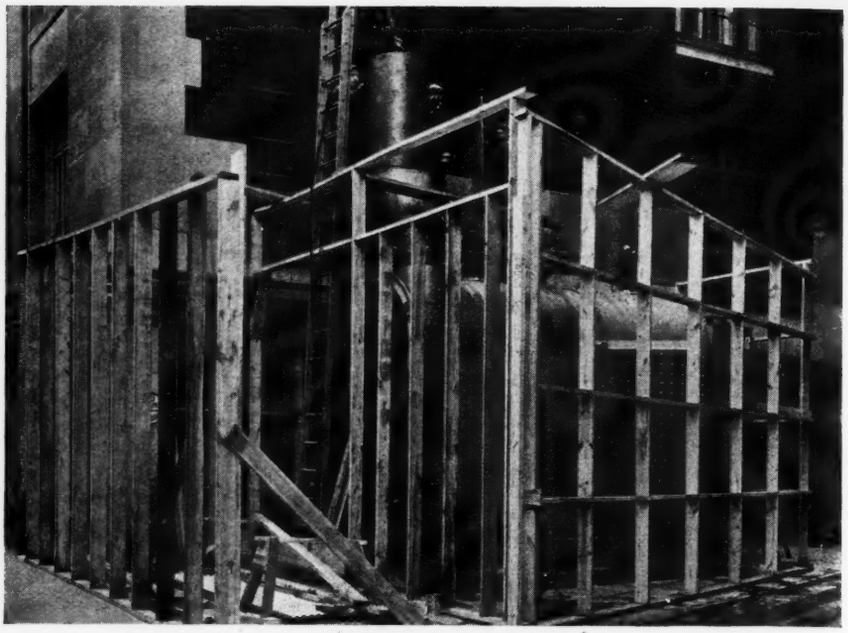
Under the auspices of the American Branch of the Newcomen Society of England, a notable group of industrial and engineering leaders gathered for the 15th Annual Dinner, April 19, at the University Club of New York. Charles Penrose, vice-president for North America, presided as toastmaster.

Charles Lyon Chandler of the Corn Exchange National Bank and Trust Co, Philadelphia, student of industrial and commercial history, reviewed technical events of 1839, a century ago.

Dr C W Colby of Montreal, distinguished Canadian scholar and business leader, delivered an address on the historical background of applied science, starting before the Christian Era and coming up to today's problems. George A Stetson, Joint Honorary Corresponding Secretary, reported upon the 1939 American Pilgrimage to Alabama in March.

Contracts Awarded For Boulder Dam Valves

Machinery for two more of the world's largest generating units was ordered May 1 for the Boulder Dam power plant. On its bid of $225,000, the Hardie-Tynes Mfg Co, Birmingham, Alabama, was awarded a contract for furnishing two 168-in. diameter butterfly valves for two of the large units to be installed in the Arizona wing of the power plant.



STANDBY FOR ALTERATIONS

Workmen erecting a temporary boiler outdoors, along the street, by the Hotel Statler, Cleveland, Ohio, for use during modernization of the hotel boiler room. Two high-pressure boilers fired by Iron Fireman stokers will go in the remodelled boiler room.

These two huge butterfly valves, 14-ft in diameter, are to be installed in the penstocks which lead water from Lake Mead to the turbines in the bottom of Black Canyon below Boulder Dam. These valves are designed to withstand a maximum hydrostatic pressure of 625 ft.

The Boulder-Dam plant, now operating at less than half of its ultimate capacity, lacks about 1000 hp of being equal to the Dnieprostroy plant in Russia, the largest hydroelectric power plant operating in the world. The capacity of that plant is 746,000 hp; present installed capacity at Boulder Dam is 745,000 hp with 4 more 115,000-hp units on order. Ultimately there will be installed 15 115,000-hp generating units and 2 smaller 55,000 units, giving a total plant capacity of 1,835,000 hp, about 2.5 times larger than the Russian plant. Only the Grand Coulee Dam power plant on the Columbia River in Washington and the Beauharnois plant on the St. Lawrence River in Canada will exceed that at Boulder Dam.

Meetings

American Institute of Electrical Engineers—*Combined Summer and Pacific-Coast Conventions, June 26–30, San Francisco, Calif. H H Henline, secretary, 33 West 39th St, New York, N. Y.*

American Society of Heating and Ventilating Engineers—*45th Semi-Annual Meeting, July 2–5, Grand Hotel, Mackinac Island, Mich. A V Hutchinson, secretary, 51 Madison Ave, New York, N. Y.*

American Society of Mechanical Engineers—*Oil and Gas Power Division Meeting, June 19–22, Ann Arbor, Michigan. Also, Semi-Annual Meeting, July 10–14, San Francisco, Calif. C E Davies, secretary, 29 W 39th St, New York, N. Y.*

Edison Electric Institute—*Annual Meeting, June 5–9, Waldorf-Astoria Hotel, New York, N. Y. M B Woods, secretary, 420 Lexington Ave, New York, N. Y.*

National Association of Power Engineers—*Annual Meeting, Aug 28–Sept 1, Claypool and Lincoln Hotels, Indianapolis, Ind. Exhibit in conjunction with meeting. Fred Raven, secretary, 176 West Adams St, Chicago, Ill.*

National District Heating Association—*Annual Meeting, June 27–30, Hotel Pennsylvania, New York, N. Y. W H Sanford, secretary, 1317 Spruce St, Philadelphia, Pa.*

Prime Mover Control Conference—*Ninth Biennial Prime Mover Control Conference, June 20–24, Rockford, Ill. Sponsored by Woodward Governor Co, Rockford, Ill.*

Smoke Prevention Association—*33rd Annual Convention, June 13–16, Hotel Schroeder, Milwaukee, Wis. C D Behan, publicity director, SPA, City Hall Square Bldg, Chicago, Ill.*

Stoker Manufacturers Association—*Annual Convention, June 1–2, French Lick Springs, Ind. Assn headquarters, 307 N Michigan Ave, Chicago, Ill.*

Ford Completes Powerhouse Enlargement

Henry Ford fired up the world's largest high-pressure industrial boiler, turning the controls on a unit completed April 13 in the No. 1 powerhouse of the Ford Motor Co's Rouge plant.

The boiler, which also is the first all-welded piping installation of its kind, will supply steam for the new 110,000-kw tubgine-generator. The new boiler will generate 900,000 lb of steam an hour at 1,400 lb and 925 F. The new generator, which is to be driven by the boiler just placed in service, is a sister to two others now in use. The total cost of the powerhouse enlargement is around $3,500,000.

NEW EQUIPMENT, POWER PLANT NO. 1.

Ford Motor Co, Dearborn, Mich.

New Boiler

Will generate 900,000 lb of steam per hr at 1400 lb and 925 F.

Photo News valve values

TITLE REG. U. S. PAT. OFFICE AS TRADE MARK

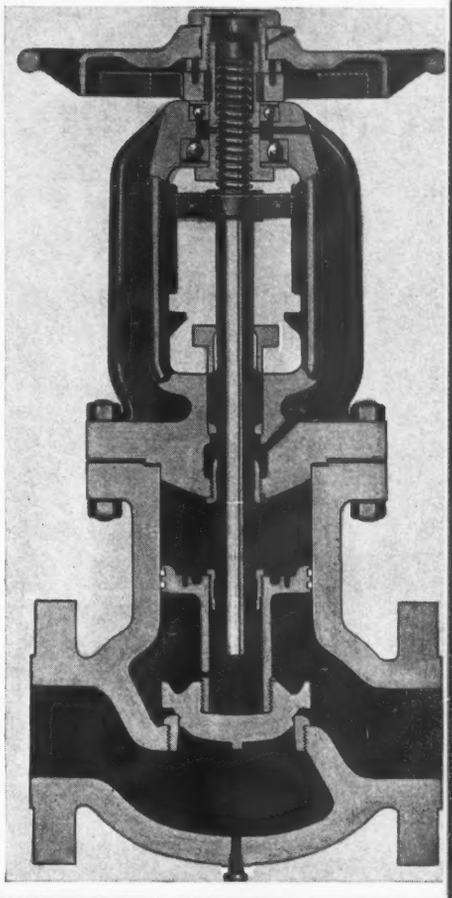
THE EDWARD VALVE & MFG. CO., INC. • EAST CHICAGO, INDIANA

STANDARDIZED -- BUT INDIVIDUALIZED!

EDWARD VALVES WILL CONFORM TO THE RECENTLY ISSUED AMERICAN STANDARDS BUT WILL RETAIN THEIR OWN IDENTITY. ALTHOUGH COMPLYING WITH APPLICABLE SPECIFICATIONS — WHETHER COVERING DIMENSIONS, CHEMICAL AND PHYSICAL CHARACTERISTICS, METHODS OF TEST, OR WHAT NOT — THERE STILL REMAIN THOSE VALUABLE THINGS WHICH REPRESENT THE BUILDER'S INITIATIVE AND EXPERIENCE AND PROVIDE CRITERIA BY WHICH TO JUDGE TRUE OPERATING VALUE OF THE PRODUCT.

HERE ARE SOME REASONS WHY.

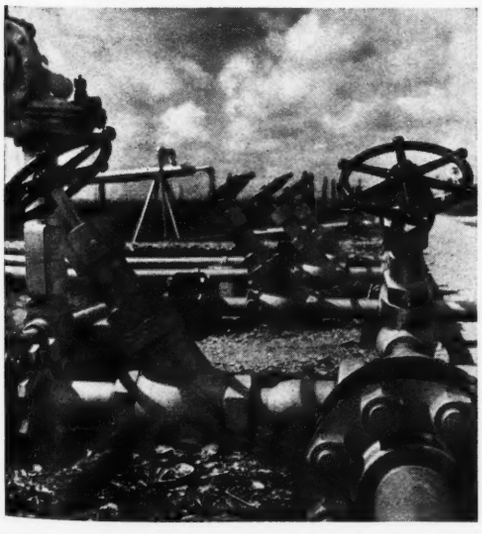
Edward non-return valves typify designs which conform to ruling standards but are individualized in detail. Standard as to controlling measurements, they are built under increasingly severe laboratory control to meet newest needs for high superheat and top pressures. Body guide ribs keep operating parts centered but without lodging space for foreign matter. Disk-piston unit is necked-in for free steam flow above disk as well as around disk, to avoid pressure loss from conflicting currents. EValloy piston rings reduce shock. Simplicity in all details. Impactor handwheel is valuable for closing the valve against test pressures, as well as for normal operation. It is a great boon to the operators, as has been proved in many plants.



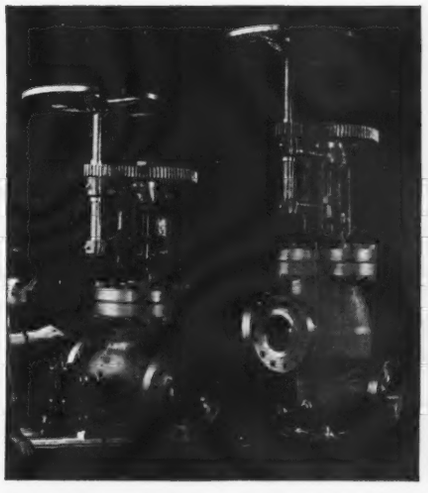
BEVELS FOR WELDING.

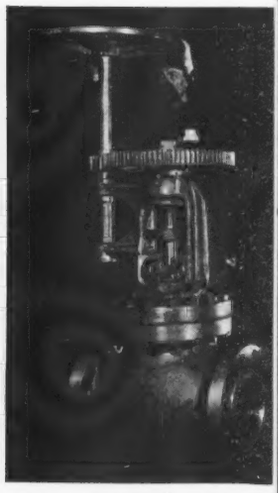
Recommended practices for machining welding ends are found in the new A.S.A. standards. A straight bevel is preferred for welding ends for thicknesses $\frac{3}{16}$ to $\frac{3}{4}$ in. and a U-bevel for thicknesses greater than $\frac{3}{4}$ in. For small forged steel valves, although not yet covered by standard, present trend is toward socket ends. Cut shows how welding bevels are machined on Edward assembled and tested steel valves.

EVERYTHING UNDER CONTROL 'NEATH TEXAS SUN.



Edward forged and cast steel valves find important uses under the blazing Texas sun. In petroleum refineries as well as in production work, Edward valves are available in a variety of designs, materials and types. Edward relief valves, for the protection of pressure vessels, are constantly gaining wider use. For steam service in boiler house or in the field Edward valves help keep up production without lost time.





SPECIAL CAST STEEL VALVES FOR HIGH SEAS.

On shipboard, space sometimes forbids use of standard sizes and types. Witness the Edward cast steel valves above especially built for ocean liner. The fundamental features of regular valves were retained.

EDWARD VALVES

Stop · Check · Blow-off · Non-return · Feed Line · Relief · Bleeder Line · etc.

NO MORE FLOODED BUS ROOM

Recently completed auxiliary bus room of West End Station, Cincinnati Gas & Electric Co. The former bus room was inundated in the 1937 flood

Heating surface of boiler proper, 24,410 sq ft
Heating surface of waterwalls, 9,500 sq ft
Heating surface of superheater, 24,019 sq ft
Heating surface of economizer, 25,200 sq ft
Heating surface of air heater, 86,016 sq ft
Total heating surface, 169,145 sq ft
Fans: 2 induced-draft @ 260 cfm each
4 forced-draft @ 70,000 cfm each
2 primary-draft @ 50,000 cfm each
Booster pumps: 2, 2535 gpm each; 1775/1525 rpm; 78% efficiency; 1771-ft head
Boiler-feed pumps: 2, 2800 gpm each; 1775/1525 rpm; 75% efficiency; 2300-ft head
High-pressure heater: capacity 840,000 lb per hr from 240 to 311 F; 2430 sq ft heating surface
Crossover heater: capacity 840,000 lb per hr from 240 to 311 F; 2340 sq ft heating surface
Deaerating heater: from 171 to 240 F; guaranteed to deliver 1,283,200 lb per hr containing not more than 0.03 cc per liter of oxygen
Low-pressure heater: capacity 688,000 lb per hr from 87 to 171 F; 3000 sq ft heating surface

New Turbine-Generator

Capacity: 110,000 kw, 80% power factor, 137,500 kva
Generators: 2, each 55,000 kw, 3 phase, 60 cycle, 13,800 volts
Turbine: vertical compound, 1215 lb throttle pressure, 925 F. 4-stage bleeding at 225, 86, 25 and 7.4 lb abs.

PERSONALS

ROLAND S HIGGINS, consulting engineer, is now associated with Hubbard Engrg Co, Chicago, Ill. He will practice consulting engineering in the power plant field.

JAMES M CURLEY, former governor of Massachusetts, was named president of the American Diesel Engine Corp, Melrose, Mass., a reorganization of the J J McCarthy Engine Co, of that city.

MAX C BARTLETT, associate engineer with Burns & McDonnell Engineering Co, has been appointed General Manager of the Water & Lighting Dept of the municipal utilities at Knoxville, Tennessee. The utilities will be under general control of a non-partisan board.

KENNETH C ELLSWORTH has been appointed manager of the Link-Belt Stoker Eastern Division, with headquarters at Philadelphia, Pa. Mr Ellsworth has been with the company since 1933, when he started as a stoker dealer. He later went to work in the stoker department in Chicago, after which he became district representative of the southern territory. January 1, 1939, he was transferred to eastern stoker headquarters at Philadelphia.

FRANK B CONLON has joined the Sheffler-Gross Co, Philadelphia, as Sales Engineer. He was formerly with the Pennsylvania Railroad, and later with the Airtemp Corp, Dayton, Ohio. Mr Conlon will specialize in sales and engineering in air conditioning, heating and ventilating.

C R MACBRIDE, formerly with the Boston Division Sales office A M Byers Co., has been appointed manager of the Engineering Service Dept of the Philadelphia Works. Mr MacBride was formerly with the Edgewater Steel Co.

EDWARD H CRABBS, Philip Carey Company, has accepted the presidency of the Executive League of America, 122 East 42nd St, New York, N. Y. The league, according to the new president, will have chairmen in 48 states and the District of Columbia, about 3,000 county chairmen, 15,000 chapter chairmen, and a minimum of about 375,000 members.

PAUL A CONDIT has recently become associated with Cooper-Bessemer Corp, Mt. Vernon, Ohio, in the capacity of Control Engineer. Mr Condit attended Denison, Ohio Northern, and Cincinnati Universities, and following graduation entered into railroad work. In 1932 he joined the Pure Oil Co, and in 1937 entered the employ of the Masoneilan Co as development engineer, serving in that capacity until his recent affiliation with the Cooper-Bessemer organization. He is a member of the American Institute of Electrical Engineers, and a Professional Electrical Engineer.

JAMES A WARD, formerly industrial sales engineer of the Republic Light, Heat & Power Co, Buffalo, has been appointed district superintendent of the Tonawanda and Kenmore districts. He has been with the company since 1930, is a native of Olean, N. Y., and a graduate of Purdue University.

VERNON WHITING, of the Stearns Magnetic Mfg Co, has been chosen sales representative for the northern section of Texas. Mr Whiting is a native of Dallas, Texas.

MARVIN W SMITH, Manager of Engrg, Westinghouse Electric & Mfg Co, was elected vice-president recently. Mr. Smith was graduated from Texas Agricultural and Mechanical College in 1915 with a bachelor of science degree in electrical engineering. He enrolled in the student engineering course at Westinghouse in 1915, and following its completion, was chosen by B G Lamme, then chief engineer, to work in his office. He held numerous positions in the company until 1926, when he was appointed Manager of Engineering. In 1938, Mr Smith received a professional degree in engineering from Texas A & M, and was also awarded the Westinghouse Order of Merit. Mr

Marvin W Smith

This risk is no longer necessary!
"EMBRITTLEMENT" TRACED TO BOILER CLEANING METHODS
Warn Against Soda Ash and Caustic Soda

Cook Out Your Boilers with NALCO No. 81

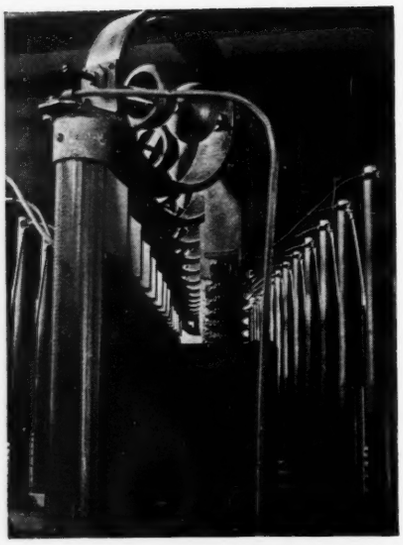
1. When starting up new boilers

2. After repairing old boilers

RECENT research work has disclosed that cooking out new or repaired boilers with soda ash or caustic soda to remove grease and oil is a practice that can lead to caustic embrittlement of the boiler metal. To protect owners of boiler plants against this hazard, the National Aluminate laboratories developed a preparation designated as Nalco No. 81. In addition to its anti-embrittling properties, No. 81 is a superior oil emulsifying agent—five times as effective as caustic soda! Complete information on how to use this product will be supplied on request. NATIONAL ALUMINATE CORPORATION, 6222 W. 66th Place, Chicago, Ill.

ANY WATER **NALCO SYSTEM** ANY PRESSURE

Inquiries other than domestic, *except those from U. S. Possessions, Canada and Mexico,* should be addressed to ALFLOC LTD., Bush House, Aldwych, London, W. C. 2, Eng. Canadian inquiries should be sent to ALUMINATE CHEMICALS LTD., 372 Bay St., Toronto, Ont.



THUNDERING BIG LIGHTNING GENERATOR

End view of 15 capacitors and gaps in the new Westinghouse surge generator which puts lightning to work in testing distribution transformers. This thunder rig can produce a steep lightning wave front of 1,500,000 volts per millionth of a second

Smith is a member of the American Association for the Advancement of Science, and the American Institute of Electrical Engineers, where he serves on the Membership, Publication and Technical Programs committees.

JOHN ROPER, formerly with Combustion Engrg Co, Inc, New York, N. Y., has joined the staff of the American K A T Corp, also of New York, in the capacity of field engineer.

BUSINESS ITEMS

INDUSTRIAL BROWNHOIST CORP announces resignation of Melvin Patterson as president and treasurer. He was elected chairman of the board of directors, when the directors met April 27. Hoyt E Hayes, vice-president, was elected president and treasurer, and James B Hayden, assistant sales manager, was appointed sales manager.

SPEEDER MACHINERY CORP, Cedar Rapids, Iowa, has been consolidated with Shovel Div, Link-Belt Co. Speeder Machinery will operate as subsidiary of Link-Belt Co, and present management will continue to operate the business. T M Deal will continue as president.

PEERLESS PUMP DIV, FOOD MACHINERY CORP, announces completion of new factory, office buildings, and testing laboratory at 301 West Avenue 26, Los Angeles, Calif. Vernon Edler is vice-president and manager.

CARBORUNDUM CORP, Niagara Falls, N. Y., announces appointment of John Storm as District Sales Manager at New York, N. Y. Headquarters will be at the branch warehouse and sales office at 601 W 26th St, N. Y. Mr Storm suc-

(Continued on page 140)

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Calif., Burbank—Cleveland Pneumatic Tool Co., L. W. Greve, pres., 3734 East 78 St., Cleveland, O., plans constructing airplane parts factory, San Fernando Rd., Hollywood Way. $200,000.

Calif., Cupertino—H. J. Kaiser Co., Latham Square Bldg., Oakland, plans constructing Portland cement manufacturing plant. Permanente Canyon 3 mi. northwest of here. $4,000,000.

Calif., Los Angeles—Helms Bakeries, 8800 Venice Blvd., plans by Grant & Bruner, archts. and engrs., 607 Ferguson Bldg., constructing 1 story, 150x160 ft., rein.-con. bakery addition. $100,000.

Calif., San Francisco—Best Foods, Inc., 1900 Bryant St., made plans constructing 3 story, rein.-con. factory, 18th and Bryant Sts. $95,000. K. Thiell, 580 Market St., engr.

Conn., Putnam—Owner, c/o L. F. Caprani, archt., 1221 Chapel St., New Haven, soon takes bids constructing 2 story, 85x400 ft., brick, steel, concrete food manufacturing plant. $150,000.

Ill., Chicago—Graham, Anderson, Probst & White, archts., 80 E. Jackson Blvd., soon lets contract constructing 1 and 2 story, basement bottling plant, 31st St. and Ashland Ave., for Joyce 7-Up, Inc., 12 Webster Ave., Joliet. $200,000.

Ill., Joliet—Graham, Anderson, Probst & White, archts., 80 E. Jackson Blvd., Chicago, soon lets contract constructing 1 and 2 story, basement bottling plant, Plainfield Rd. and E.J.&E. R.R., for Joyce 7-Up, Inc., 12 Webster Ave. $200,000.

Ill., South Elgin—Bids about May 31, by Winnebago Distillery Co., c/o P. Gerhardt, archt., 447 Fullerton Parkway, Chicago, constructing whiskey distillery, 8 story storage warehouse building, boiler house, administration bldg., granary, vat buildings, on 30 acre tract, S.H. 25, Kane Co., near here. $750,000.

Ia., Clinton—Continental Grain Co., 7900 Van Buren St., St. Louis, Mo., plans constructing (1st unit) grain elevator. $100,000.

Ia., Marshalltown—State, Des Moines, plans constructing powerhouse at soldiers' home. $60,000.

Ia., Muscatine—Bids May 31, by City, constructing municipal power plant improvements. Young & Stanley, Inc., Muscatine, engrs.

Ia., Preston—City, election soon to vote bonds constructing municipal electric light and power plant. Approximately $45,000.

Ky., Burkesville—**City plans constructing** electric power plant, Diesel engine, generator units, etc. $65,000. S. Watkins, McClelland Bldg., Lexington, consult. engr.

Mich., Holland—Bids May 24, by H. Geerlings, mayor, general contract constructing power plant superstructure, circulating water tunnels, outfall sewer for electric generating plant, brick, steel, concrete, for City. PWA. Hamilton & Weeber, Federal Sq. Bldg., Grand Rapids, and Giffels & Vallet, 1000 Marquette Bldg., Detroit, engrs.

Minn., Hibbing—Bids May 25, by Village, c/o Water, Light, Power & Building Comn., J. P. Murphy, secy., furnishing, installing turbine generator unit, surface condenser, etc., at heating and generating plant. $305,000. Burlingame, Hitchcock & Estabrook, 521 Sexton Bldg., Minneapolis, engrs.

Miss., Iuka—W. G. Goodman, Tupelo, plans constructing paper mill and installing machinery. $4,500,000. Applied for R.F.C. loan.

Mo., Jefferson City—Bids about June 1, by State Building Comn., c/o Bi-Partisan Advisory Bd., E. M. Eagan, executive secy., Merchants Bank Bldg., renovating and remodeling boiler plant, at Missouri State Penetentiary, approximately $110,000; diesel engine generating power plant at Auxiliary Prison, Algoa, near here, approximately $50,000. Baumes Eng. Co., 1871 Railway Exch. Bldg., St. Louis, Mo., engrs.

Mont., Fort Peck—U. S. Eng., Postal Telegraph Bldg., Kansas City, Mo., plans furnishing, installing one 16,000 kva and one 40,000 kva generators, $600,000, and 50,000 hp. and 20,000 hp. turbines with governor and parts, $400,000, in connection with Fort Peck power project. Maturity soon.

Neb., Beatrice—Gage County Electric Co., C. F. Shaffer, mgr., soon takes bids constructing 36x185 ft. flour mill, 750 bbl. daily capacity, also hydro-electric plant 23 ft. square, 58 ft. high, one generating unit. C. L. Cone, Beatrice, engr.

N. J., Wood Ridge—Asbestos Cement Pipes, Inc., 225 Bway., New York, plans constructing asbestos pipe factory building at Erie R.R. near Saddle River Rd. $300,000. F. L. Smith & Co., 225 Bway., New York, archts.

N. Y., Brooklyn—News Syndicate Co., Inc., 220 E. 42 St., New York, plans altering, extending 8 story printing plant, 684-716 Pacific St. $250,000. Lockwood Greene Engineers, Inc., 30 Rockefeller Plaza, New York, engrs.

N. Y., Buffalo—General Mills, Inc., D. D. Davis, pres., 200 Chamber of Commerce Bldg., Minneapolis, Minn., 9 story, basement, 72x316 ft., rein.-con., brick flour mill, packaged cereals manufactory and warehouse. Total est. $2,000,000. Bids soon for 1st section. McEnary & Krafft, 715 Rand Tower, Minneapolis, Minn., archts. for exterior design only. Cereal Eng. & Constr. Co., 529 S. 7 St., Minneapolis, Minn., consult. engrs.

N. Y., Buffalo—Hecker Products Corp., St. Clair and Louisiana Sts., plans constructing additional flour mill building, near St. Clair St. Over $100,000. Maturity soon. Engineer, c/o owner, engr.

N. Y., Newark—Village Bd., L. H. Wright, supt. P. Wks., plans constructing municipal power plant. To exceed $150,000. Engineer not appointed. Funds appropriated for retaining engineer to make survey and sketches.

N. Y., Schenectady—New York Power & Light Corp., 511 State St., plans constructing new power substation, 3,000 kw. capacity, on Watt St. To exceed $25,000. Private plans.

N. Y., Syracuse—Delaware, Lackawanna & Western R.R. Co., 120 Bway., New York. G. A. Phillips, Hoboken, N. J., ch. engr., plans reconstructing industrial buildings, railroad sidings, demolition of buildings. $241,000. Above work is preliminary to grade crossing elimination project, estimated to cost $6,000,000. To be financed wholly by owners.

Okla., Cushing—City voted bonds 400 hp. Diesel engine generator set and switchboard for municipal light and power plant. $31,500. W. L. Austin, Cushing, engr.

S. C. Abbeville—City rejected bids Apr. 28, constructing hydro-electric power house. $342,520. PWA. Wiedeman & Singleton, Candler Bldg., Atlanta, Ga., engrs.

Tex., LaGrange—Town, H. Landrum, defeated bonds, municipal electric power plant and distribution system. $220,000.

Tex., Weslaco—Atlantic Refining Co., Weslaco, and Corpus Christi, plans constructing natural gas recycling plant south of here, in new gas-distillate fields. $450,000 or more.

Wash., Seattle—Union Pacific R.R., S. Murray, div. engr., Pittock Blk., Portland, Ore., plans constructing meat packing plant, 4th Ave. S. $125,000. Rath Packing Co., 3433 E. Marginal Way, lessee.

W. Va., Weirton—Weirton Steel Co., plans constructing structural mill scheduled for completion July 1, also reconstructing other units, making possible increase of more than 200% in potential production. $500,000. Private plans.

Wis., Genoa—Tri-State Power Cooperative Co., Boscobel, soon takes bids constructing steam electric generating plant, south of here. $500,000. A. Y. Taylor & Co., 8025 Forsythe Blvd., Clayton, Mo., engrs.

B. C., Kootenay—Sherritt Gordon & Sudbury Basin Mines Ltd., c/o J. A. Campbell, 789 W. Pender St., Vancouver, plans re-developing silver lead properties in old St. Eugene Extension Mine, Kootenay Dist. $3,000,000. Private plans.

B. C., Okanagan—Maurice Chaplin, c/o Central Okanagan Vegetable Growers Assn., plans constructing sugar beet factory. $100,000. Negotiating for site.

Man., Winnipeg—Maple Leaf Milling Co., Port Colbourne, plans constructing flour mill, 1,000 bbl. per day, either in Winnipeg or St. Boniface, suburb of Winnipeg. $250,000.

N. S., Bridgewater—Municipality, constructing additional hydro-electric development, Petite Riviere, capacity 600 hp., day labor. $100,000. C. B. MacDougald, P. O. Box 602, engr.

Ont., Garson—International Nickel Co., D. McCaskill, genl. mgr., Copper Cliff, constructing heating plant, sorting plant, steel head frame, hoisting equipment to handle 200 tons per hour, shops, 5 compartment steel shaft 2,215 ft. deep, own forces. $2,500,000. Private plans.

Ont., Kirkland Lake—Malartic Gold Fields Ltd., J. P. Norris, genl. mgr., 276 St. James St. W., Montreal, Que., soon takes bids constructing 300 ton mill, also an addition to mill for East Malartic Co. $75,000.

Ont., Simcoe—Utilities Comn., W. D. Stalker, mgr., wants prices for installing electric unit at Cedar St. Station. $30,000.

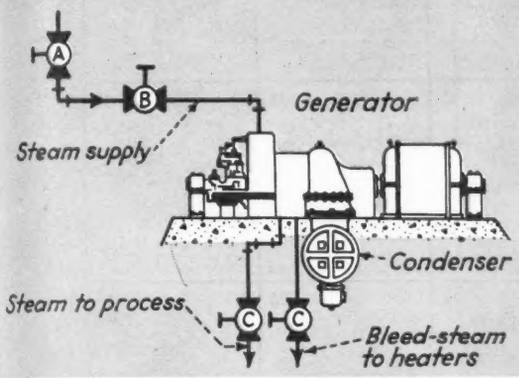
Que., Arvida—Aluminum Co. of Canada, Ltd., 1010 Ste. Catherine St. W., Montreal, soon takes bids constructing pot room addition to plant. $150,000. Private plans.

Sask., Saskatoon—City Clerk taking bids constructing power development addition. $300,000. G. D. Archibald, Saskatoon, engr.

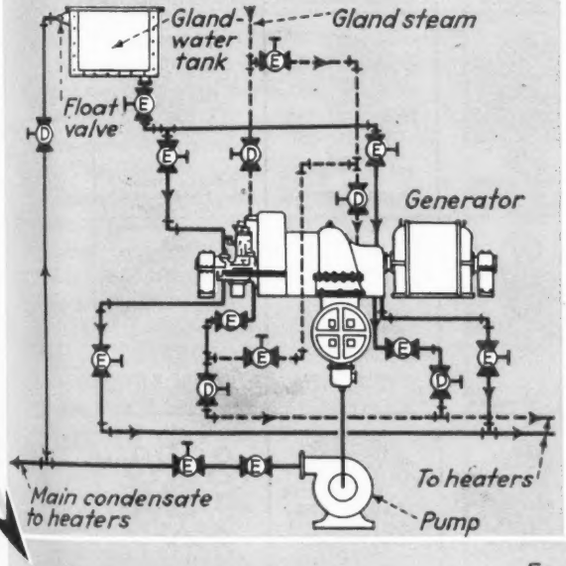
. . . TO *GOOD* VALVE PRACTICE

Jenkins RECOMMENDS . . .

MAIN STEAM



GLAND SEALS

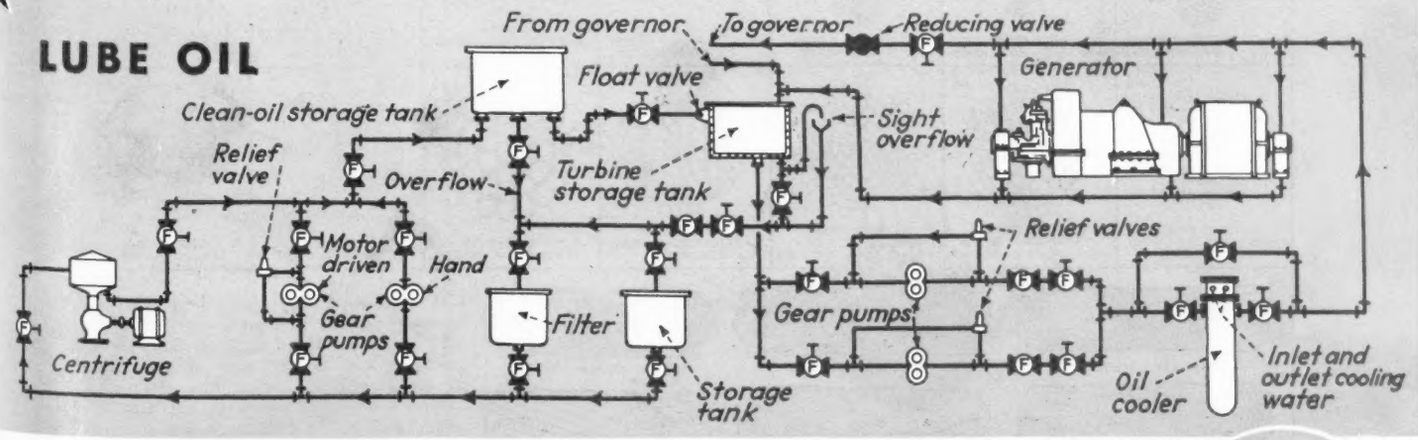


REFERENCE CHART FOR JENKINS FIGURE NUMBERS

		Up to 100 lbs. S.P.	Up to 200 lbs. S.P.	Up to 300 lbs. S.P.	Up to 400 lbs. S.P.	Up to 600 lbs. S.P.
A	STEAM HEADER GLOBE	IRON 613 Fl. Regrinding 913 Fl. Regrinding 142 Fl. Disc Type	IRON 162 Fl. Disc Type 923 Fl. Regrinding STEEL 1042 Fl. 30 Series	STEEL 1042 Fl. 30 Series	STEEL 1044 Fl. 40 Series	STEEL 1046 Fl. 60 Series
	ANGLE	IRON 615 Fl. Regrinding 915 Fl. Regrinding 144 Fl. Disc Type	IRON 163 Fl. Disc Type 925 Fl. Regrinding STEEL 1043 Fl. 30 Series	STEEL 1043 Fl. 30 Series	STEEL 1045 Fl. 40 Series	STEEL 1047 Fl. 60 Series
	GATE	IRON 651 Fl. O.S. & Y.	IRON 204 Fl. O.S. & Y. STEEL 1010 Fl. 30 Series	STEEL 1010 Fl. 30 Series	STEEL 1011 Fl. 40 Series	STEEL 1012 Fl. 60 Series
B	STOP VALVE GLOBE	IRON 613 Fl. Regrinding 913 Fl. Regrinding	IRON 923 Fl. Regrinding STEEL 1042 Fl. 30 Series	STEEL 1042 Fl. 30 Series	STEEL 1044 Fl. 40 Series	STEEL 1046 Fl. 60 Series
	ANGLE	IRON 615 Fl. Regrinding 915 Fl. Regrinding	IRON 925 Fl. Regrinding STEEL 1043 Fl. 30 Series	STEEL 1043 Fl. 30 Series	STEEL 1045 Fl. 40 Series	STEEL 1047 Fl. 60 Series
C	BLEED GATE	IRON 325 Sc. Non-Rising 326 Fl. Non-Rising 650 Sc. O.S. & Y. 651 Fl. O.S. & Y. STEEL 1009 Fl. 15 Series	IRON 203A Sc. Non-Rising 203 Fl. Non-Rising 204A Sc. O.S. & Y. 204 Fl. O.S. & Y. STEEL 1010 Fl. 30 Series	STEEL 1010 Fl. 30 Series	STEEL 1011 Fl. 40 Series	STEEL 1012 Fl. 60 Series
D	GLAND STEAM GLOBE	BRONZE 106A Sc. Disc Type 750 Sc. Regrinding 950 Sc. Regr-Renew	BRONZE 801 Sc. Disc Type 950 Sc. Regr-Renew 1140 Sc. Regrinding 1150 Sc. Regr-Renew	BRONZE 970 Sc. Regr-Renew		
E	SEALING WATER GLOBE	Same as "D" above	Same as "D" above	Same as "D" above		
F	GATE	BRONZE 47 Sc. Travel Spind. 49 Sc. Travel Spind. 370 Sc. Non-Rising 670 Sc. Non-Rising 368 Sc. O.S. & Y. IRON 325 Sc. Non-Rising 326 Fl. Non-Rising 650 Sc. O.S. & Y. 651 Fl. O.S. & Y.	BRONZE 270 Sc. Non-Rising 275 Sc. O.S. & Y. IRON 251 Sc. Non-Rising 255 Fl. Non-Rising 277 Sc. O.S. & Y. 253 Fl. O.S. & Y.	BRONZE 280 Sc. Non-Rising 282 Sc. O.S. & Y. IRON 203A Sc. Non-Rising 203 Fl. Non-Rising 204A Sc. O.S. & Y. 204 Fl. O.S. & Y.		
	SWING CHECK	BRONZE 352 Sc. Disc Type 762 Sc. Regrinding IRON 623 Sc. Regrinding 624 Fl. Regrinding 294 Sc. Disc Type 295 Fl. Disc Type	BRONZE 762 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type	BRONZE 260 Sc. Disc Type 962 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type		
G	OIL LUBRICATION GLOBE	Same as "D" above	Same as "D" above	Same as "D" above		
	GATE	BRONZE Same as "E" above	BRONZE Same as "E" above	BRONZE Same as "E" above		
	GLOBE NEEDLE	BRONZE 743 Sc. Needle 741 Sc. Needle	BRONZE 703 Sc. Needle 705 Sc. Needle	BRONZE 703 Sc. Needle 705 Sc. Needle		
	ANGLE NEEDLE	BRONZE 744 Sc. Needle 742 Sc. Needle	BRONZE 704 Sc. Needle 706 Sc. Needle	BRONZE 704 Sc. Needle 706 Sc. Needle		
	SWING CHECK	BRONZE 352 Sc. Disc Type	BRONZE 762 Sc. Regrinding	BRONZE 260 Sc. Disc Type 962 Sc. Regrinding		

Motor operated Iron and Steel Valves can be supplied.
Cast Steel Valves with ends for welding can be supplied.

LUBE OIL



JENKINS BROS., 80 WHITE STREET, NEW YORK, N. Y.

Bridgeport • Boston • Chicago • Philadelphia • Atlanta • Houston

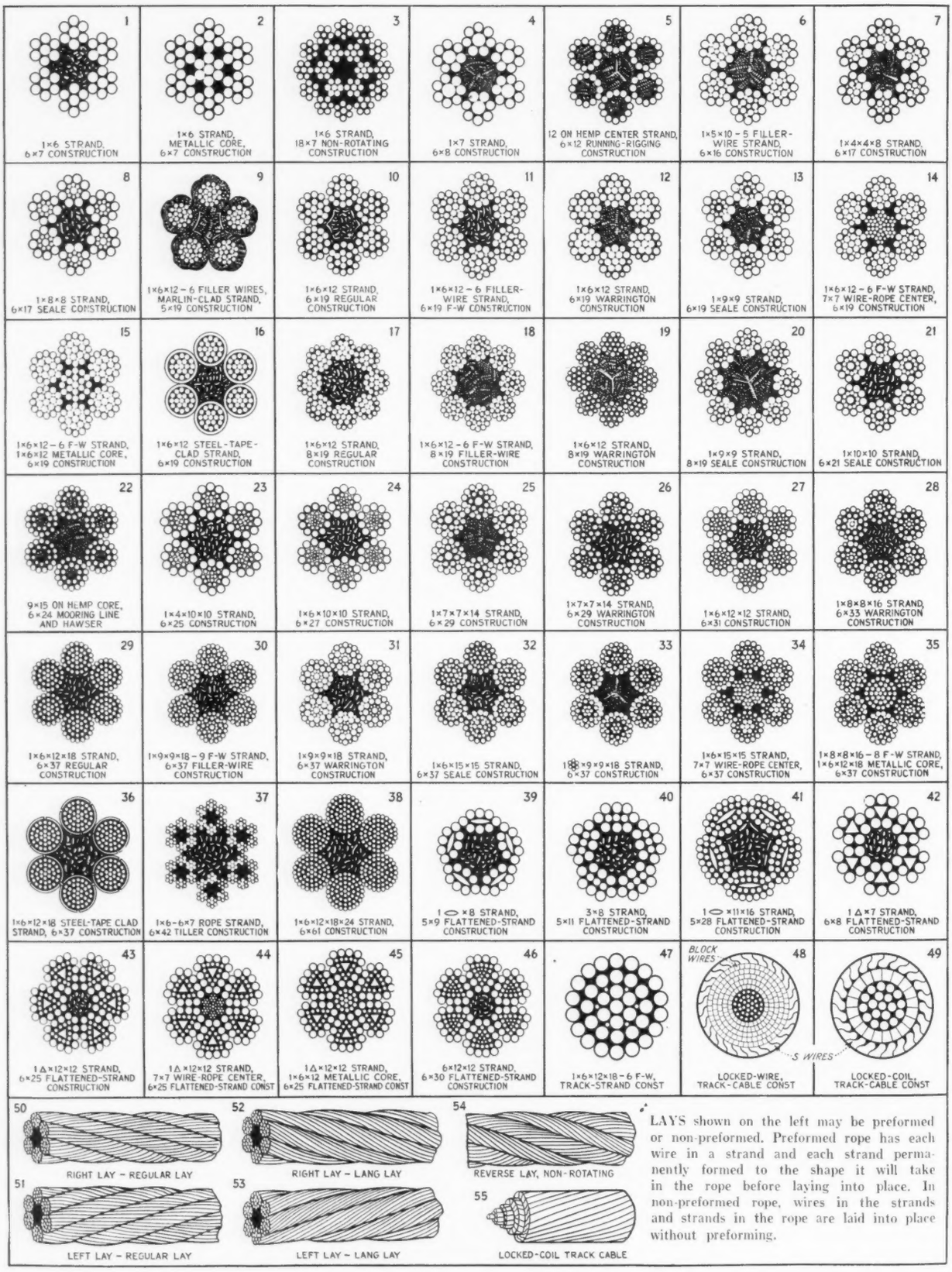
REG. U.S. PAT. OFF. TRADE JENKINS MARK Jenkins Bros.

1864—1939 DIAMOND ANNIVERSARY

#6 OF A SERIES designed to help in your selection of JENKINS VALVES

Number 83

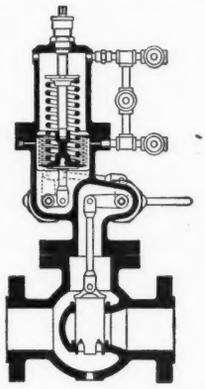
Typical Wire-Rope Constructions


1 1×6 STRAND, 6×7 CONSTRUCTION
2 1×6 STRAND, METALLIC CORE, 6×7 CONSTRUCTION
3 1×6 STRAND, 18×7 NON-ROTATING CONSTRUCTION
4 1×7 STRAND, 6×8 CONSTRUCTION
5 12 ON HEMP CENTER STRAND, 6×12 RUNNING-RIGGING CONSTRUCTION
6 1×5×10 – 5 FILLER-WIRE STRAND, 6×16 CONSTRUCTION
7 1×4×4×8 STRAND, 6×17 CONSTRUCTION
8 1×8×8 STRAND, 6×17 SEALE CONSTRUCTION
9 1×6×12 – 6 FILLER WIRES, MARLIN-CLAD STRAND, 5×19 CONSTRUCTION
10 1×6×12 STRAND, 6×19 REGULAR CONSTRUCTION
11 1×6×12 – 6 FILLER-WIRE STRAND, 6×19 F-W CONSTRUCTION
12 1×6×12 STRAND, 6×19 WARRINGTON CONSTRUCTION
13 1×9×9 STRAND, 6×19 SEALE CONSTRUCTION
14 1×6×12 – 6 F-W STRAND, 7×7 WIRE-ROPE CENTER, 6×19 CONSTRUCTION
15 1×6×12 – 6 F-W STRAND, 1×6×12 METALLIC CORE, 6×19 CONSTRUCTION
16 1×6×12 STEEL-TAPE-CLAD STRAND, 6×19 CONSTRUCTION
17 1×6×12 STRAND, 8×19 REGULAR CONSTRUCTION
18 1×6×12 – 6 F-W STRAND, 8×19 FILLER-WIRE CONSTRUCTION
19 1×6×12 STRAND, 8×19 WARRINGTON CONSTRUCTION
20 1×9×9 STRAND, 8×19 SEALE CONSTRUCTION
21 1×10×10 STRAND, 6×21 SEALE CONSTRUCTION
22 9×15 ON HEMP CORE, 6×24 MOORING LINE AND HAWSER
23 1×4×10×10 STRAND, 6×25 CONSTRUCTION
24 1×6×10×10 STRAND, 6×27 CONSTRUCTION
25 1×7×7×14 STRAND, 6×29 CONSTRUCTION
26 1×7×7×14 STRAND, 6×29 WARRINGTON CONSTRUCTION
27 1×6×12×12 STRAND, 6×31 CONSTRUCTION
28 1×8×8×16 STRAND, 6×33 WARRINGTON CONSTRUCTION
29 1×6×12×18 STRAND, 6×37 REGULAR CONSTRUCTION
30 1×9×9×18 – 9 F-W STRAND, 6×37 FILLER-WIRE CONSTRUCTION
31 1×9×9×18 STRAND, 6×37 WARRINGTON CONSTRUCTION
32 1×6×15×15 STRAND, 6×37 SEALE CONSTRUCTION
33 1×9×9×18 STRAND, 6×37 CONSTRUCTION
34 1×6×15×15 STRAND, 7×7 WIRE-ROPE CENTER, 6×37 CONSTRUCTION
35 1×8×8×16 – 8 F-W STRAND, 1×6×12×18 METALLIC CORE, 6×37 CONSTRUCTION
36 1×6×12×18 STEEL-TAPE CLAD STRAND, 6×37 CONSTRUCTION
37 1×6–6×7 ROPE STRAND, 6×42 TILLER CONSTRUCTION
38 1×6×12×18×24 STRAND, 6×61 CONSTRUCTION
39 1 ⬭ ×8 STRAND, 5×9 FLATTENED-STRAND CONSTRUCTION
40 3×8 STRAND, 5×11 FLATTENED-STRAND CONSTRUCTION
41 1 ⬭ ×11×16 STRAND, 5×28 FLATTENED-STRAND CONSTRUCTION
42 1 △×7 STRAND, 6×8 FLATTENED-STRAND CONSTRUCTION
43 1 △×12×12 STRAND, 6×25 FLATTENED-STRAND CONSTRUCTION
44 1 △×12×12 STRAND, 7×7 WIRE-ROPE CENTER, 6×25 FLATTENED-STRAND CONST
45 1 △×12×12 STRAND, 1×6×12 METALLIC CORE, 6×25 FLATTENED-STRAND CONST
46 6×12×12 STRAND, 6×30 FLATTENED-STRAND CONSTRUCTION
47 1×6×12×18 – 6 F-W, TRACK-STRAND CONST
BLOCK WIRES
48 LOCKED-WIRE, TRACK-CABLE CONST
S WIRES
49 LOCKED-COIL, TRACK-CABLE CONST
50 RIGHT LAY – REGULAR LAY
51 LEFT LAY – REGULAR LAY
52 RIGHT LAY – LANG LAY
53 LEFT LAY – LANG LAY
54 REVERSE LAY, NON-ROTATING
55 LOCKED-COIL TRACK CABLE

LAYS shown on the left may be preformed or non-preformed. Preformed rope has each wire in a strand and each strand permanently formed to the shape it will take in the rope before laying into place. In non-preformed rope, wires in the strands and strands in the rope are laid into place without preforming.

© POWER

The COPES Type SDS-2 Pump Governor



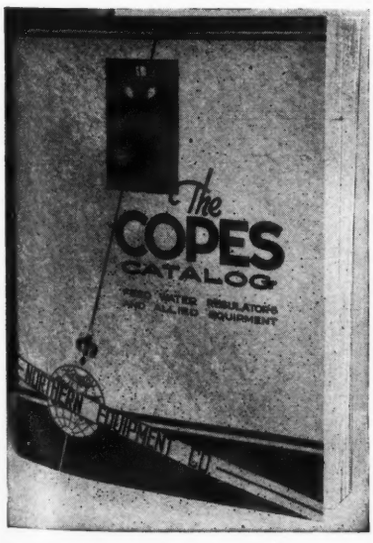
Good feed water regulation begins with a good pump governor, and that is why the COPES Type SDS-2 Governor was developed.

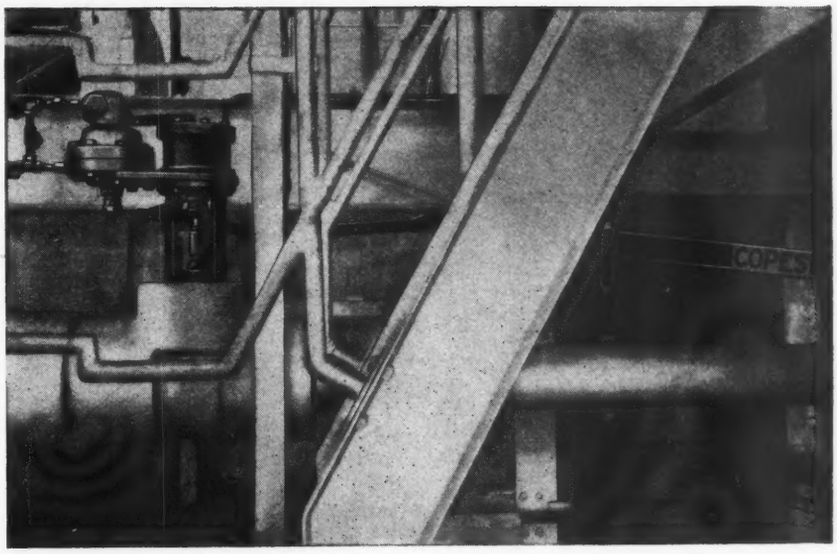
Most of the more than 36,000 COPES Feed Water Regulators in service are used in connection with some type of pump governor. None that we have ever seen has given as uniformly accurate and dependable results as this one. Subjected to the severest service conditions we could find during the last seven years, the record of perfect satisfaction has been 98% plus.

Designed for remote control of the excess feed water pressure. Engineered for the individual installation to assure close regulation. Built for long service life, and delivering it in hundreds of plants.

The Type SDS-2 Governor is described in the COPES Catalog of Feed Water Regulators and Allied Equipment, your most complete reference on feed water regulating equipment. If it is not in your files—

Write for this Catalog





Southern Alkali Corporation

reports boiler water level held within ±½ inch

You can read about this COPES Flowmatic installation in an interesting article—Water Level Control on Southern Alkali Corporation's New Integral Furnace Boiler, by Mr. G. R. Avery, Steam and Power Engineer at the Corpus Christi plant. In regular service, the water level is held within plus or minus ½ inch. On test, the COPES Flowmatic has demonstrated unusual ability to stabilize the water level on rapid, wide load swings. If you are interested in closer boiler water level control, write for Mr. Avery's article. Ask for Bulletin 417.

NORTHERN EQUIPMENT CO., 611 GROVE DRIVE, ERIE, PA.

Feed Water Regulators, Pump Governors, Differential Valves
Liquid Level Controls, Reducing Valves and Desuperheaters

BRANCH PLANTS IN CANADA, ENGLAND, FRANCE, GERMANY, AUSTRIA AND ITALY . . . . REPRESENTATIVES EVERYWHERE

Get closer level control with the

COPES

FEEDS BOILER ACCORDING TO STEAM FLOW•AUTOMATICALLY

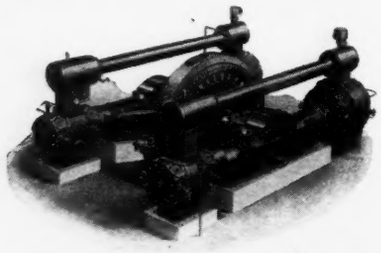
FLOWMATIC

★ REGULATOR

What's New in Plant Equipment

Motor-Driven Compressors

LARGER, direct-connected, synchronous-motor-driven compressors feature "four corner" construction of two low- and two high-pressure cylinders having single motor and single crankshaft. Incorporated in larger-size machines is force-feed lubrica-

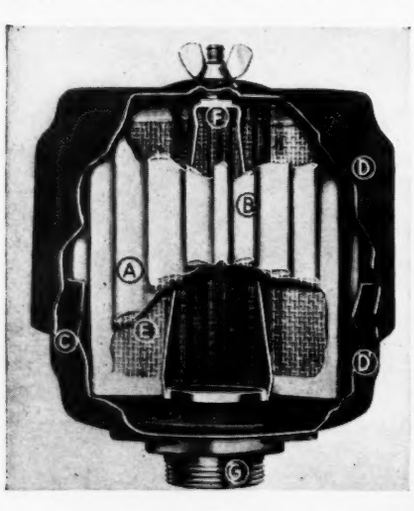


tion and turret-type channel valves. Duplex units are built in sizes from 600 to 800 hp, and "four corner" machines are available in sizes from 7800 to 3000 hp.

Ingersoll-Rand Co, 11 Broadway, New York, N. Y.

Air Filter

"PROTECTOMOTOR" air filter is dry-type for small internal-combustion engines, compressors, pumps, etc. In illustration, *A* indicates patented radial fin construction, said to provide largest filtering area in smallest possible space, while *B* shows dry Feltex filtering medium, constructed to allow free air flow while retaining smallest particles of matter. Intake *C* is approximately double the outlet area, said to keep friction and turbulence of entering

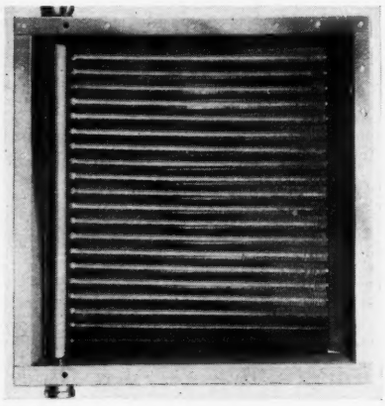


air at a minimum. Weatherproof housing shown at *D* and *D*¹. Yoke and bolt supporting upper shell are spot welded. Heavy wire mesh backs filter unit, *E* and yoke *F*. Threaded flange *G* provides easy removal or insertion of entire unit. Upright and hanging models available in capacities from 3 to 225 cfm, and wide selection of pipe sizes.

Staynew Filter Corp, 25 Leighton Ave, Rochester, N. Y.

Heater Section

LOW RESISTANCE to air flow claimed to be outstanding advantage of heater section which may be operated by either steam or hot water for heating, and cold water or refrigerant for cooling. Constructed of finned copper tubes of hairpin design secured to headers by mechanical compression. Expansion and contraction is taken care of by shape of tubes, and although tubes are easily opened, method of attachment to headers is said to keep them permanently tight. Series of built-

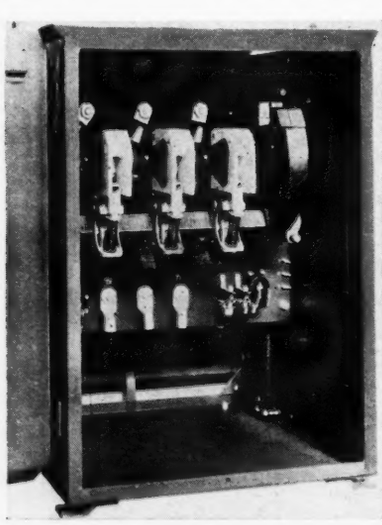


in bypasses actuated either manually or automatically provides control of discharged-air-stream temperature. Each completed section is subjected to steam test of at least 150 lb and hydrostatic pressure of 1,000 lb.

L J Wing Mfg Co, 154 W 14th St, New York, N. Y.

Non-Reversing Linestarters

FEATURES of linestarters include low-voltage protection or release through low-voltage relay, bi-metal type of overload relay, hand or automatic reset, saturated current transformers, and magnetic blowouts. Saturated transformers said to insure ade-

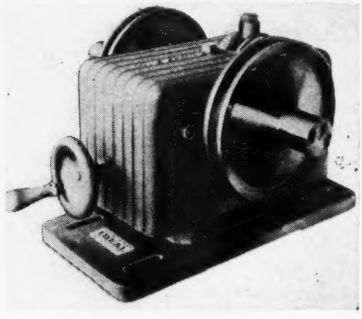


quate protection on slow-starting applications, and blowouts claimed to insure adequate arc-rupturing capacity. Available in four sizes: 300-amp rating, 100 hp at 220 v, 200 hp at 440/600 v; 600-amp rating, 200 hp at 220 v, 400 hp at 440/600 v; 750-amp rating, 250 hp at 220 v, 500 hp at 440/600 v; 1200-amp rating, 400 hp at 220 v, 750 hp at 440/600 v. All ratings are 3-wire, 2- or 3-phase.

Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.

Hand Wheel Control

"SELECT-O-SPEED" transmissions built with hand wheel control permit finer adjustments of speeds, partial turns of wheel changing speed. Models supplement standard line from fractional to 7½-hp capa-

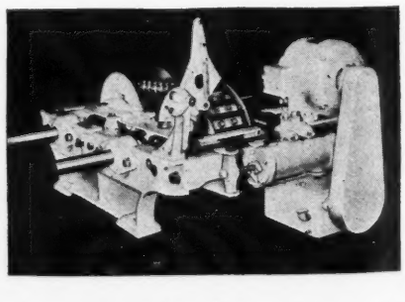


city which are equipped with hand lever control. By replacing hand wheel with beveled gears and extension rod, control may be made remote or more convenient.

Ideal Commutator Dresser Co, 1025 Park Avenue, Sycamore, Ill.

Hydraulic Control

CONTROL provides automatic speed regulation to make possible synchronization of different machines, or separate sections of a single machine. Control is mounted at one end of transmission frame, and self-contained hydraulic power-plant is mounted on right-hand set of shifting-levers of transmission, which control disk and belt diameters. Plant consists of small elec-



tric motor operating oil pump in reservoir to supply hydraulic power. 2-way valve is mounted integral with cylinder immediately above reservoir. Piston connects to left-hand set of shifting levers, while cylinder connects to right-hand set.

MORE PUMP FOR LESS MONEY!

That's What Plant Managers Say About SSUnit . . . The Fast-Selling Allis-Chalmers Pump . . . that Gives Them New Pumping Savings!

It means something when men responsible for production in their plants say SSUnit pumps are giving them new lows in pumping costs... actually paying for themselves in big savings!

For that's what Allis-Chalmers engineers — the same engineers that designed and built the great Niagara Falls and Boulder Dam turbines—were shooting at when they originated the first motor-coupled pump in 1926!

And today that SSUnit pump is making news with its big, extra value features that make it the biggest, most profitable pump buy on the market!

You'll Like SSUnits!

You'll like the compact, husky design that cuts maintenance costs . . . beats space waste . . . lets you put the unit in any position you want it. The bronze construction of the enclosed runner, wearing rings and shaft sleeves . . . your protection against excessive wear and rust!

And because SSUnit Pumps are completely tested before delivery you know they're ready to go to work for you the minute they are installed.

Performance That Cuts Costs!

But you don't stop there! For coupled to the pump is the famous, Full-Measure constructed Allis-Chalmers Lo-Maintenance Motor . . . the motor that has proven performance records of beating conditions that many times wreck ordinary motors in a few weeks.

BEATING A SPACE PROBLEM IN A large brewery is only one of the ways this Allis-Chalmers SSUnit Centrifugal Pump (driven by a Lo-Maintenance Motor) is proving its adaptability and money-saving value!

There's no buck passing . . . Allis-Chalmers accepts full responsibility for both the motor and the drive.

Get started on real pumping savings today! Call the nearest district office or write direct to Allis-Chalmers, Milwaukee, Wis.

1097

. . . 90 Years of Engineering Superiority Work for You When You Specify Allis-Chalmers!

CENTRIFUGAL PUMP DIVISION

ALLIS-CHALMERS

MILWAUKEE · WISCONSIN

Valve directs flow of oil to either right- or left-hand side of piston, operating either way to increase or decrease transmission speeds. Equalizing links placed between two pairs of shifting levers insure equal movement on both pairs and maintain perfect alignment of transmission V-belt in the disks. Valve is actuated by rod which connects to extended lever above. Lever may be attached by cable, chain, or directly to a compensating or floating roll, pressure regulator, moving carriage or part of the driven machine, from which indication of required speeds can be taken. Control lever may be located any place on 360-deg circle to give direct connection to operating mechanism.

Reeves Pulley Co, Columbus, Ind.

Well Pumps

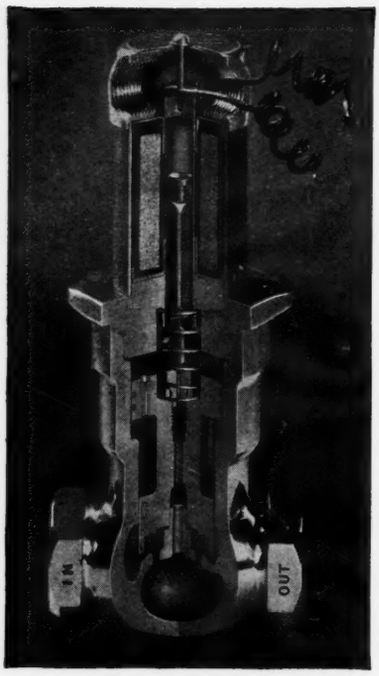
CRANE "K" SERIES shallow-well pumps offered in 250- and 375-gal. capacities for horizontal and vertical tank systems. Designed for 40-lb minimum pressure with 22-ft suction lift, having 1-in. suction and

¾-in. discharge. Deep-well pump, D-60, illustrated, has load-balancing cylinder and herringbone gears. Available with different sizes of load-balancing cylinders, giving flexibility to meet operating conditions.

Crane Co, 836 S Michigan Ave, Chicago, Ill.

Electric Valve

"ATKOMATIC" valves adaptable for difficult continuous operations on steam up to 150 lb, and operations where accuracy of operation is desired. Has only three moving parts. Non-metallic valve-disks said to insure maximum wear and tight-seating for each particular service. Plunger is corrosion resistant, and all parts are of



stainless-steel or bronze. Electrical connections may be placed in any position and all parts are accessible without removal from line.

E C Atkins & Co, 452 S Illinois St, Indianapolis, Ind.

Blueprint Reproducer

"ELPRO" printer makes positive prints from tracings, drawings, plans, specifications, etc, in from 1 to 5 minutes in sizes up to 12x18 in. Consists of case in which Ozalid dry-process paper is inserted, together with drawing or tracing to be reproduced. Case is closed for specified time, then exposed print is rolled and put into ammonia developer case. After development, reproduction is ready for use. Operates on 110 ac current and can be supplied for 110 dc current.

Electronic Products Mfg Corp, 208 W. Washington St, Ann Arbor, Mich.

Pneumatic Relays

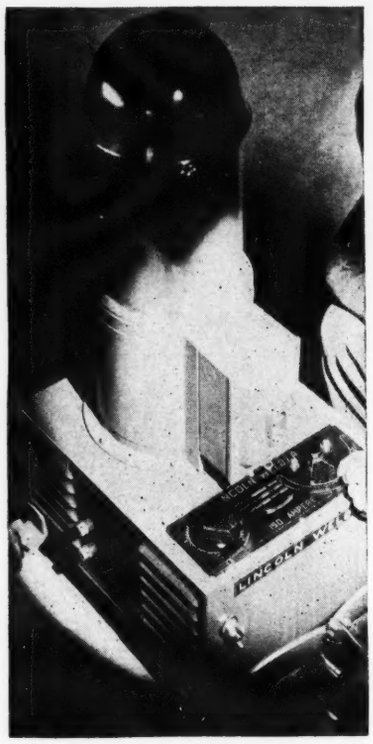
COMPLETE line of pneumatic relays for temperature-control systems are applicable to central fan and similar systems, unit ventilators, small central-fan systems, and

include electric, diverting and graduate type relays. Diverting relay is air-operated and can be used to divert source of air into either of two outlets, or can be used to feed air to branch line in one position, and stop the main line and bleed the branch line in other position. Graduate type transmits control pressure in air line leading from thermostat or other controlling device, to greater number of control motors or valves that controlling device, by itself, would be unable to operate. Electric-pneumatic relays are arranged so that when fan is shut down, relays will close outdoor damper and shut off means for supplying humidity to system.

Minneapolis-Honeywell Regulator Co, 2950 Fourth Ave, South, Minneapolis, Minn.

Arc Welder

TYPE SA-150 Motor-generator arc-welder said to provide greater convenience and accuracy because of self-indicating dial continuous current control. Both job selector and current control calibrated and equipped with dials which indicate type of work and number of amperes for each setting. Welder has current range of from 45 to 200 amps,



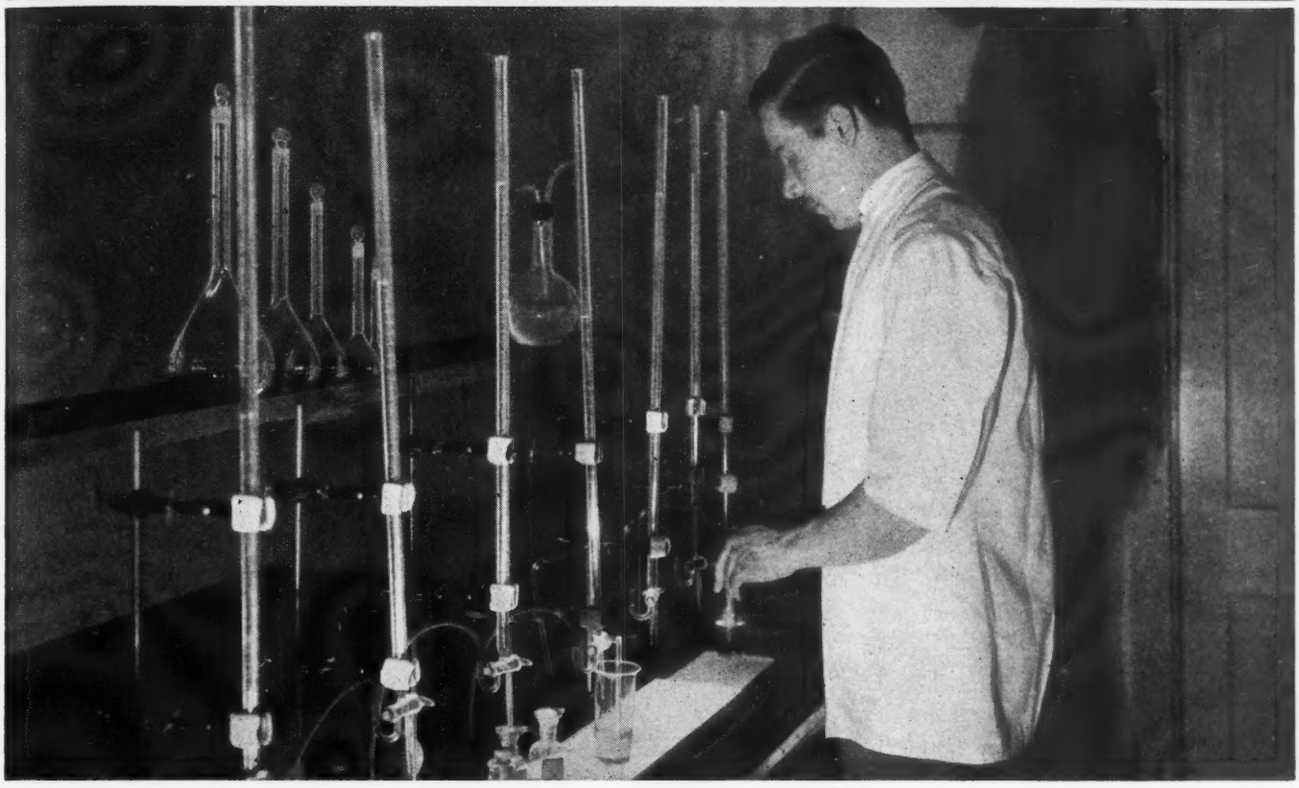
and can be used with either bare- or shielded-arc electrodes. Is powered with squirrel-cage induction motor for across-the-line starting. Connections are accessible for either 220 or 440 volts, 2- or 3-phase, 50- or 60-cycles. For special uses, machine can be supplied for any voltages.

Lincoln Electric Co, 12818 Coit Road, Cleveland, Ohio.

Bypass Chemical Feeders

APPLICABLE either for treatment of boiler water or as treatment of domestic water, feeders are available in capacities of from 2 to 20 gals., and at maximum pressures of 150 and 300 lb. They are used to introduce chemical solution into water line either by shot feed, or proportional to rate of flow. Feeders can be supplied

$H_2O + ?$



The Answer to Your WATER PROBLEM
is an Ever Changing Chemical Equation

It can only be determined by those grounded in technical education and a thorough practical knowledge as qualifications for experienced interpretation of careful and continuous analysis as a basis for scientific and reliable control.

Let these unbiased, unselfish and eminently qualified consultants on *all* water problems audit your water conditions as an accountant would your books.

The cost is small and the improvements and economies worthwhile.

No matter what your water problem may be, process, sanitation, boiler water or waste disposal, you have but to call this one organization for the answer.

W. H. & L. D. BETZ, 235 W. Wyoming Avenue, Philadelphia
Branch Offices at 50 CHURCH STREET, NEW YORK • 37 W. VAN BUREN STREET, CHICAGO
Chemical Engineers Strategically Located

CONSULTATION
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BETZ

BOILER WATER
PROCESS WATER
MUNICIPAL WATER
WASTE DISPOSAL

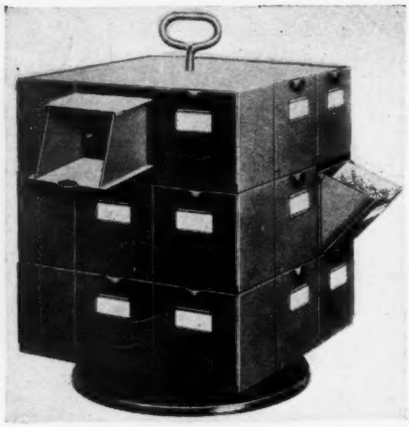
Chemical Engineers and Consultants on All Water Problems

with variable-orifice valves and gage glass.

Milton Roy, 2031 East Madison St, Philadelphia, Pa.

Storage Bin

"SPIN-A-BIN" provides compact storage space for plant or factory, consisting of bins attached to revolving assembly. Bins are spot-welded, 26-gage steel, and are finished in green. Unit contains 24 bins



either 3x3x2½-in., or 4x4x3-in. in size, in which bolts, washers, screws, etc, can be stored. Description of contents may be written on front of each compartment. In either model, double-width bin may be substituted for two of single-width.

Noggle Products Company, Ann Arbor, Mich.

Pillow Block

LIGHT-WEIGHT, patented pillow block consists of three parts, is said to have increased oil capacity, and full constant self-alignment. Available in shaft sizes

from ½-in., to 1-in, and can be mounted in any position.

Randall Graphite Products Corp, 609 West Lake St, Chicago, Ill.

Plastic Seal

"DUXEAL" said to retain plasticity indefinitely, and can be used for sealing water, fume, air or electrical conduits of metal, tile, or fibre; soil pipe, or glass block. Seal is applied by knife or by hand, after joint has been cleaned, and said not to stick to the hands or knife. Available in three consistencies, light, medium, and heavy, colored brown unless specially ordered, and is packed in 5-, 10-, 25-, and 50-lb slabs. One pound equals 14 cu in.

X-Pando Corp, 43-15 36 St, Long Island City, N. Y.

Steel Shim Stock

"ECONOMY" kit contains rolled assortment of most frequently used thicknesses of thin steel shim stock packed in carton. Thicknesses from .001, .002, .003, .005 in., can be pulled through slot in carton and cut off in desired lengths.

Laminated Shim Co, 21-44 44th Ave, Long Island City, N. Y.

Vertical Motors

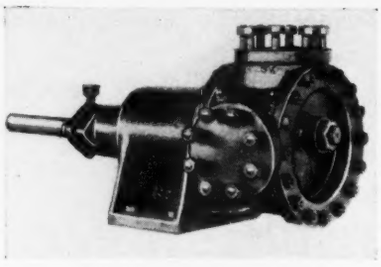
"SYNCROGEAR" unit, type GDV, with flange base, illustrated, was designed to meet conditions peculiar to vertical operation. Small geared oil pump is incorporated in

construction to supply bearings, gears, and pinions with sufficient continuous lubrication.

U. S. Electrical Motors, Inc, Los Angeles, Calif.

Hydraulic Pump

CAPACITIES of 50, 90, and 200 gpm offered in new line of hydraulic pumps. Similar to smaller pumps, larger ones operate under pressures up to 500 lb psi on oil

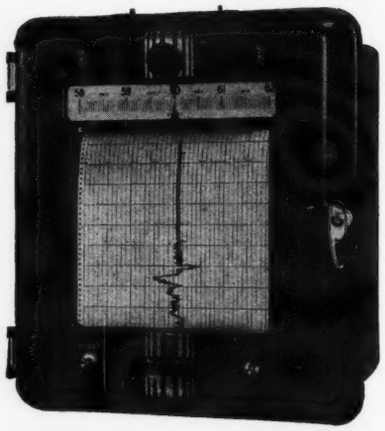


free from grit or abrasives. 200-gal. size illustrated is equipped with inner radial roller bearings on rotor shaft, and thrust is carried on duplex outer ball thrust bearing locked against shoulder on rotor shaft. All pumps have right-hand port design, except 200-gal. size, in which port can be changed from right to left by removing bolts from back flange.

Viking Pump Co, Cedar Falls, Iowa

Frequency Controller

"MICROMAX" controller provides isolated generating plants with automatic frequency control. Combines in one case Micromax frequency indicator and recorder, with an automatic controller. Recorder requires roll of chart and ink every two

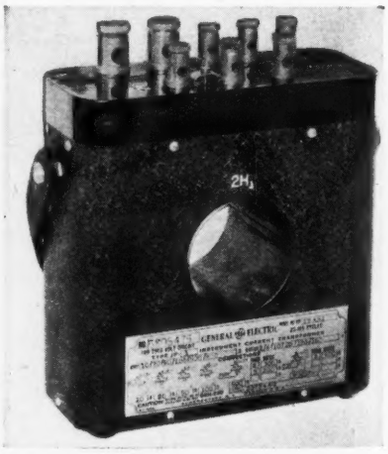


weeks, with lubrication and cleaning twice yearly. Maintenance costs said to be extremely low, operator being able to make any adjustments necessary at long intervals.

Leeds & Northrup Co, 4907 Stenton Ave, Philadelphia, Pa.

Field-Testing Current Transformer

JP-1 portable current transformer has combination of wound-primary and through-primary construction, with tap in secondary, used to obtain more ratios. Core



window is 2¾-in. in diameter. Primary ratings of 10, 20, 50 and 100 amp are obtained from wound primary with terminals in top of case. Passing primary cable throughout the core window once obtains ratings of 600—800 amp; passing it through two or more times obtains ratings

(*Continued on page 134*)

For non-rust water heaters

1. For New York Central Health Center, New York City, 42″ d. x 120″

2. For Brooklyn Library, Brooklyn, N. Y., 36″ d. x 96″

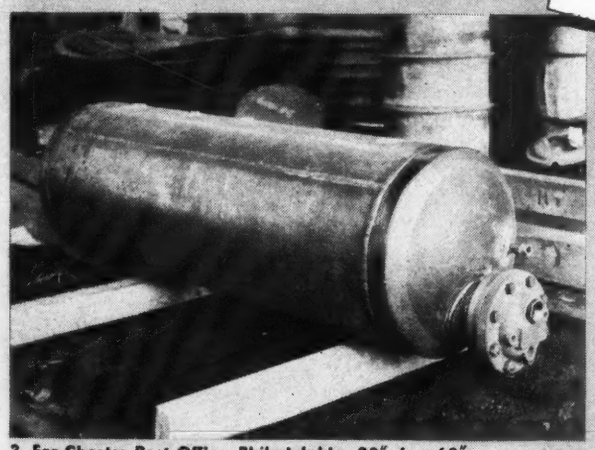
EVERDUR gets the call

There's good reason for the fact that nowadays more Everdur heaters are installed in a week than were built in the entire year 1929. Owners more and more realize that the "cheapness" of rustable heaters is apt to prove a false economy... that *true economy* lies in the use of heaters that *do not rust.* That's why building owners from coast to coast are demanding non-rust Everdur heaters for rust-free hot water and long heater life.

EVERDUR Copper-Silicon Alloy is exceptionally strong, rustless as copper, and readily welded. This rare combination of properties means rust-free hot water for years to come, and lasting service at low cost. For all types of installations—industrial, commercial and residential—storage heaters of Everdur are obtainable from leading equipment manufacturers.

All of these welded Everdur Heaters were fabricated by QUAKER CITY IRON WORKS, Philadelphia, Pa.

3951



3. For Chester Post Office, Philadelphia, 20″ d. x 60″

4. For Northport School, Northport, L. I., 48″ d. x 96″

Everdur TANK METAL ANACONDA from mine to consumer

THE AMERICAN BRASS COMPANY, General Offices: Waterbury, Connecticut

In Canada: Anaconda American Brass Ltd., New Toronto, Ont. • Subsidiary of Anaconda Copper Mining Co.

Hindsight Into Foresight...

THE YOUNGSTER next door was being told off by his dad for his mistakes. Looking up a little tearfully, the kid said, "If today was yesterday, I'd do some things different."

There's a lot behind that simple statement. Most of us have pretty sound hindsight, but our foresight isn't all it should be. We will wait until it's raining before we mend a leaky roof, or lock a barn after the horse is stolen. Then we wish we'd remembered; you know: "If wishes were horses, beggars might ride."

Foresight doesn't come from just wishing; the only way you can get it is by training yourself, by sitting back once in a while and thinking about things that are likely to happen and figuring out what to do if they do.

I know a lot of folks will fuss at that suggestion. Lord knows I've been bawled out often enough as a "calamity howler" for trying to figure out in advance the consequences of some action of mine. And insurance agents haven't got a friend in the world. But the planning they suggest, and the planning I try to do, are both darn handy later on.

It always makes me feel better when I see a watch engineer go get a wrench and fix a leak when it first shows up. I've even seen a fireman carefully clean up an oil spot or move some timbers back so there'll be no sliding or tripping afterwards.

It's such things that sooner or later build an engineer's reputation for knowing what to do in a jam. In the first place, he doesn't run into many jams, because he's anticipated them. When he does hit one, he's figured out beforehand what to do. He's developed foresight; he doesn't have to wish childishly to have another try at yesterday.

George Edwards

Engineer

This test CHANGED *chain design*

This destruction test, pictured above, made during 1934, opened new fields for applications of long pitch chains, where maintained accuracy is vital in transmitting power. The properties of Nickel alloy steels, with their high strength/weight ratio, permitted modern redesigning which cut weight—and costs—over heavier chains formerly forged from plain carbon steel. This 10″ link showed an ultimate strength of 455,000 lbs., a yield point of 388,000 lbs. — 30% higher than U. S. Engineer specifications.

Roller chains, with 12¼″ pitch, control roller gates on Mississippi River Dam 14, LeClaire, Iowa. Link-Belt Company used Nickel alloy steels to specifications of U. S. Engineer Office. Side bars are SAE 3140, Brinell 300-341, rollers SAE-3140, 300-341 Brinell, and pins SAE 3245, 340-380 Brinell. Triple width assemblies have an estimated ultimate strength of 2,250,000 lbs.

Dams on the upper Mississippi control water levels to provide navigable channels and guard against sudden floods. Dam gates are moved by roller chains of Nickel alloy steels. On hard jobs you can safeguard performance, keep costs down, by specifying Nickel alloy steels for all highly stressed units.

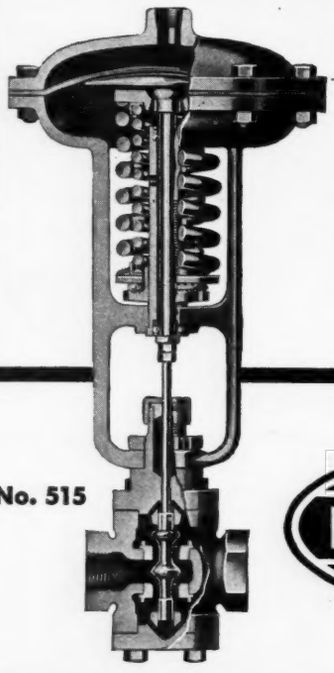
ALLOY NICKEL STEELS

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

Responsive Reliable Rugged

The Versatile "500 SERIES" Regulators

These reducing valves hold process or heating steam pressures within required limits—responding swiftly to variations, giving reliable service for years with a minimum of maintenance. Like other Masoneilan regulators they are built to give you extra value in accuracy and durability. Use them anywhere indoors to control steam pressures up to 250 lbs. (reducing to ranges between 8 oz. and 195 lbs.) for heating, power or pump pressure regulation. There are types for every purpose. These and many other Masoneilan Regulators are fully described in Bulletin No. 64. Ask your mill supply distributor for your copy—or write our nearest office.



No. 515

MASONEILAN

REG.U.S.PAT.OFF.

1186 ADAMS STREET, BOSTON, MASS., U. S. A.

NEW YORK PHILADELPHIA BUFFALO PITTSBURGH CHICAGO
ST. LOUIS TULSA HOUSTON LOS ANGELES

New Equipment

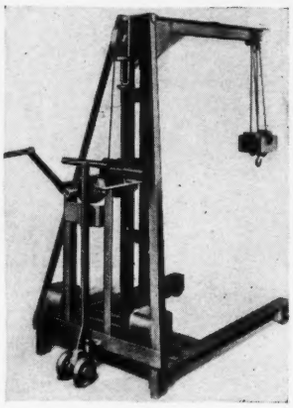
(Continued from page 130)

of 150, 200, 300, 400 amp. Transformer's secondary rating is 5 amp. Primary and secondary connections for the various ratios are indicated on diagrammatic name plate.

General Electric Co, Schenectady, N. Y.

Shop Crane

PORTABLE shop crane, either electrically or manually operated, is of welded steel, with capacities from 500 to 5,000 lb, with either fixed or revolving boom. Boom uprights



can be made rigid, upright, hinged, or telescoping to negotiate low overhead clearances or doorways. Unit mounted on roller bearing wheels, and, when lifting or lowering, front wheels are raised so that members supporting the upright boom contact the floor, giving firm footing.

Barrett-Cravens Co, 3255 W 30th St, Chicago, Ill.

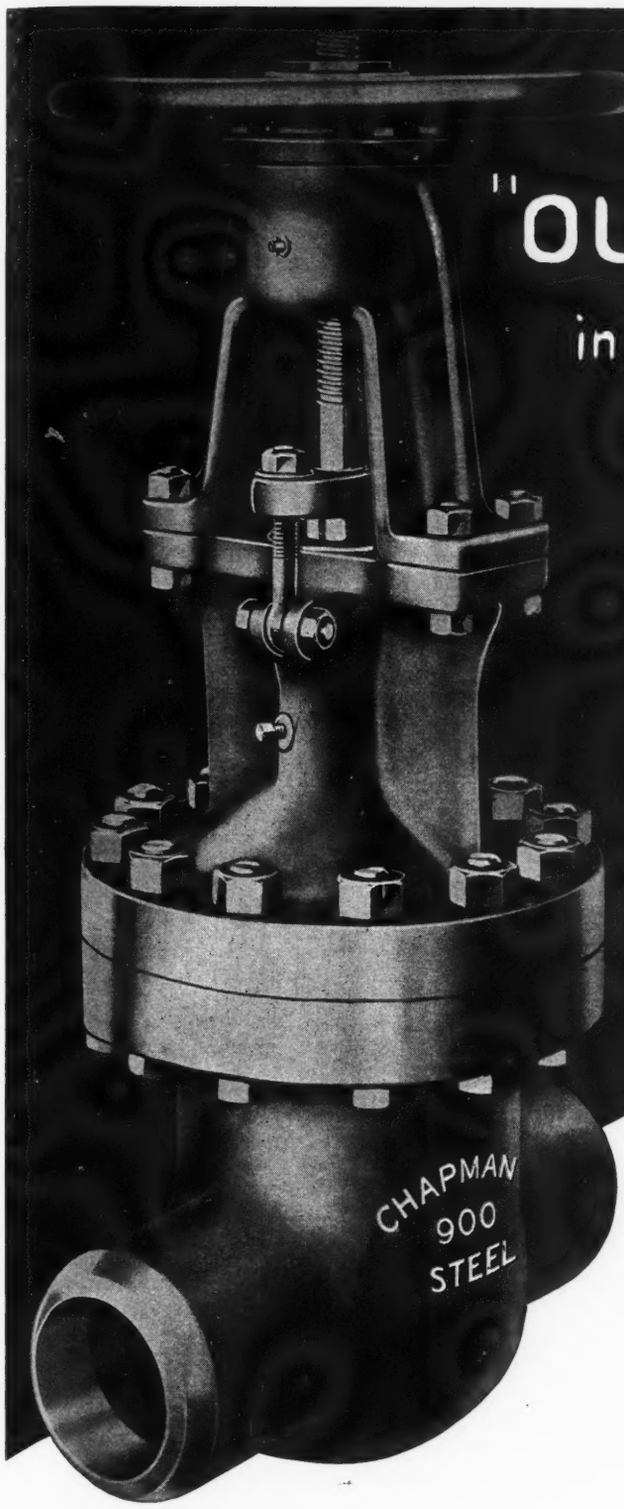
Pipe and Bolt Machine

MODEL-C portable pipe and bolt machine built so that two men can work at machine simultaneously and will thread pipe up to and including 2-in., and bolt up to 1½-in. Will operate geared tools to thread pipe up to 8-in., and is able to stop and start at heaviest point of cutting. Gears are totally enclosed and run in oil, and have antifriction bearings. Can be used either on bench or stand and weighs about 140 lb. Available with either 110- or 220-volt Universal motor.

Beaver Pipe Tools, Inc, Warren, Ohio

Plate Type Evaporator

EVAPORATOR has been worked out for freezing of ice to be accumulated or stored for use in storage refrigeration applications for air conditioning. Evaporator is constructed by using section of steel pipe or copper tube, *A*, 8 to 10 in., in diameter, length of which is governed by evaporator capacity. Steel sheet, *B*, is welded midpoint on each side of cylinder, and both sheets of metal are joined at bottom as indicated. In interior of evaporator re-



Typical Chapman Steel Gate Valve
with Welding Ends for
High Pressure, High Temperature Steam

"OUTSTANDING"

in Quality and Service

CHAPMAN

STEEL VALVES

for the

MODERN POWER PLANT

The quality inherent in Chapman Steel Valves is the logical result of painstaking research and development to meet the exacting demands of modern steam practice.

Specific service requirements for high strength, corrosion resistance or weldability, involve the skillful casting and heat treating of a diversity of steel alloys. This is done in Chapman's own foundries under expert metallurgical supervision and control.

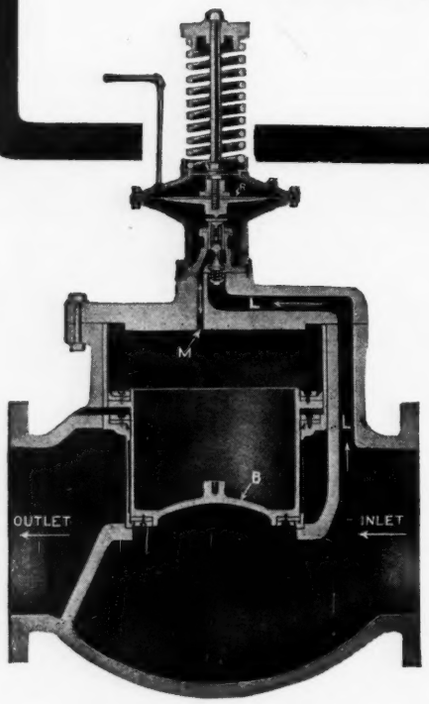
Chapman products are "outstanding" because of unremitting effort and long experience.

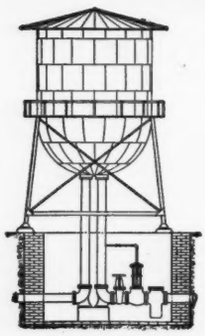
THE CHAPMAN VALVE

MANUFACTURING COMPANY

INDIAN ORCHARD, MASS.

Golden-Anderson SPECIALTY VALVES





ALTITUDE CONTROL

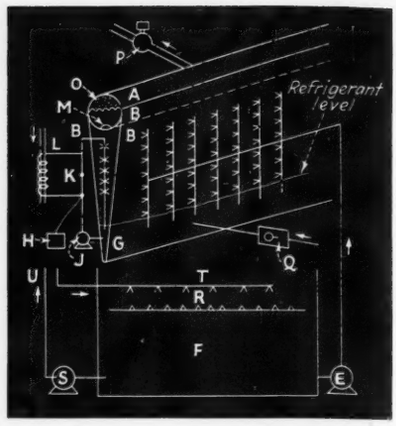
● No tank or standpipe can overflow if equipped with a G-A Altitude Control Valve. Maintains automatic water level at all times. Positive in action. Air and water cushioned. Full bronze trim with no metal contacts. No water hammer or shock. Sizes 2" to 36" in angle or globe patterns. Write for illustrated catalog for full details on the complete G-A line.

also

Emergency Throttle . . . Float Control . . . Pressure Reducing . . . Triple Acting Non-return . . . Check Valves . . . Etc.

Golden-Anderson Valve Specialty Co.

Fulton Bldg. • • • Pittsburgh, Pa.



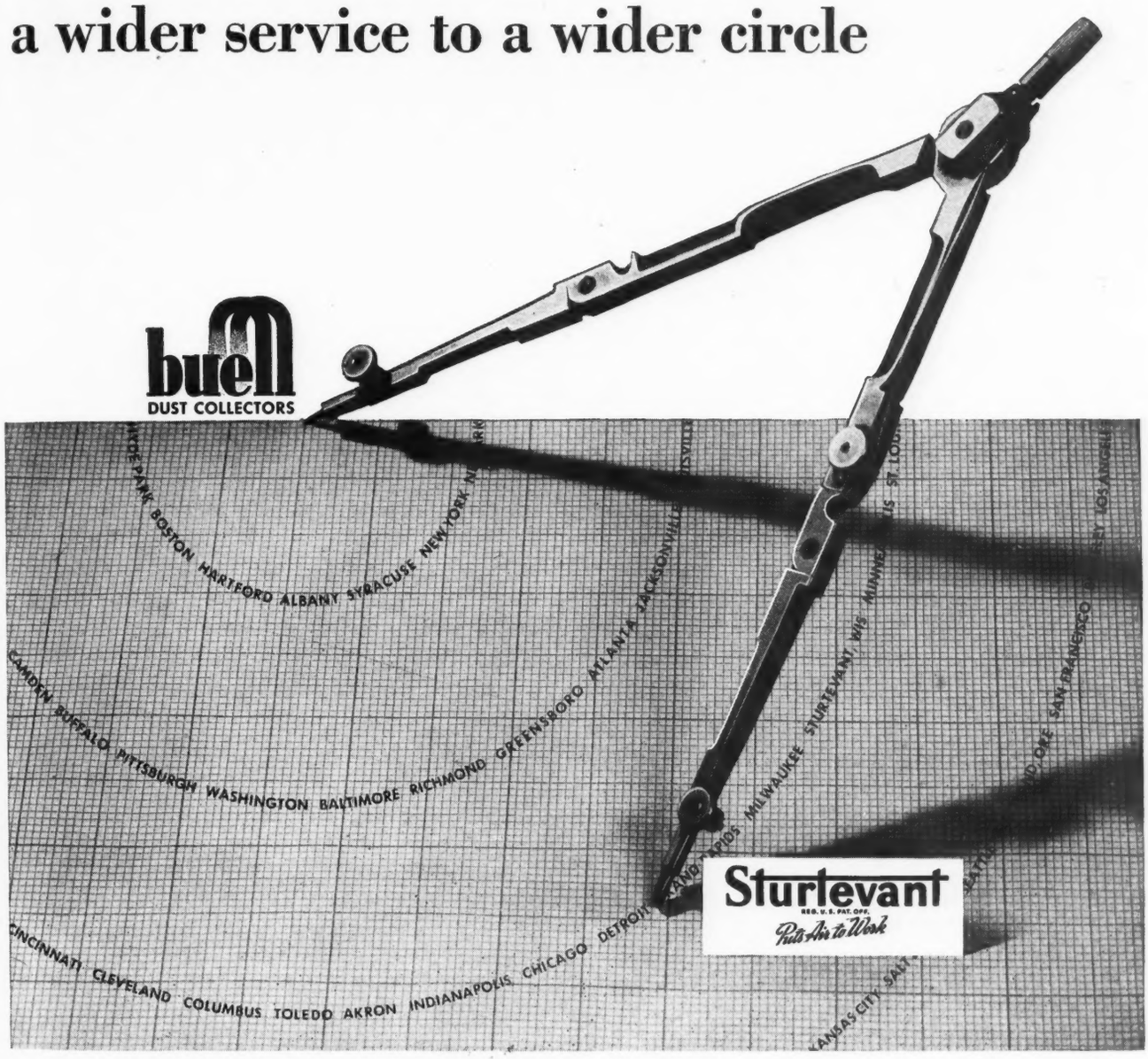
frigerant is sprayed through nozzles of spray nozzle manifold. Outside the evaporator, along the sides of plate, water is sprayed from the nozzles of spray bank, *D*. Water is furnished these nozzles by circulating pump, *E*, drawing water out of an insulated tank, *F*. Any water not frozen on evaporator drops back into tank where ice is also deposited. Refrigerant is withdrawn from evaporator at *G* by special "Freon" pump *J* and is circulated over refrigerant spray bank *C*. Timing device *H* operates 3-way solenoid valve which diverts flow of refrigerant through heat exchanger, *L*, a length of pipe wrapped around the discharge line between the compressor and the condenser. Check valve *K* insures correct flow of refrigerant. By circulating refrigerant through heat exchanger, it is warmed and warm refrigerant is sprayed against the sides of the evaporator, loosening sheet of ice, which falls to the pointed grid *R*, which in turn breaks the ice into pieces and drops those pieces into the tank. Valve *P* prevents overloading of compressor, being operated by timing device, *H*. Defrosting cycle takes few seconds. Lower half of cylinder *A* is divided by plate, *O*, below which is thin stuffing of steel or copper wool. Series of holes are drilled in bottom portion of cylinder *A* as indicated by *M*. There is also series of perforations in plate *O*. Metal wool serves to prevent any free drops of refrigerant from being carried over to high side. As refrigerant is condensed, it is re-admitted to evaporator by float valve, *Q*. When chilled water is required for air-conditioning system, of which this unit is part, it is withdrawn through pump *S*, circulated to and returned from the point of use *U*. Water is sprayed over the ice through spray-bank manifold, *T*, thus re-chilling water.

Carl F Boester, 101 E Essex, Kirkwood, St Louis, Mo.

High-Capacity Magnetic Contactor

Several interesting features incorporated in new 600- and 1,200-amp contractors, Arrangement of blowout circuit permits concentrating magnetic flux where most useful. Contact arrangement allows placing blowout side plates close together. Blowout magnetic field kept in phase with arc-path current by laminations on blowout core and side plates. Compact construction obtained by mounting 1-in. wide

Now STURTEVANT and BUELL bring a wider service to a wider circle


buell
DUST COLLECTORS
HYDE PARK BOSTON HARTFORD ALBANY SYRACUSE NEW YORK
CAMDEN BUFFALO PITTSBURGH WASHINGTON BALTIMORE RICHMOND GREENSBORO ATLANTA JACKSONVILLE
CINCINNATI CLEVELAND COLUMBUS TOLEDO AKRON INDIANAPOLIS CHICAGO DETROIT MILWAUKEE STURTEVANT MINNEAPOLIS ST. LOUIS
DENVER SAN FRANCISCO LOS ANGELES
SEATTLE
KANSAS CITY
Sturtevant
REG. U. S. PAT. OFF.
Puts Air to Work

When H. Van Tongeren worked out in Holland those principles of advanced aerodynamic design which are associated with his name and applied them to dust collection, the efficiency of the cyclone was markedly increased, the range of its usefulness greatly widened.

When the Buell Engineering Company, sole American licensee under the Van Tongeren patents, made the new type of cyclone available to the industries of this country, the circle of users quickly widened and the need for a wider field service became apparent.

Today that need is met. The B. F. Sturtevant Company is now complementing Buell's own service through the 40 Sturtevant offices—complementing, too, the Buell Dust and Fly Ash Collectors with Sturtevant's many types of related equipment.

No matter where you are located you can now be sure to find, close at hand, a coordinated service rendered by engineers who are thoroughly qualified not only to discuss with you your dust collection and fly ash problems, but also to aid you in the selection of any necessary fan equipment.

THE ONLY CYCLONES WITH A DUST POCKET • MORE THAN 1100 IN USE

FOR INFORMATION on dust collection ask us for *Bulletin D81*; on fly ash, for *Booklet A93*. Either, or both, will be sent free to any managing executive or operating engineer.

B. F. STURTEVANT COMPANY, HYDE PARK, BOSTON, MASS. ✣ BUELL ENGINEERING COMPANY, INC., 10 CEDAR STREET, NEW YORK

Insist upon the welding fittings that alone combine these eight features.

TAYLOR FORGE
★WeldELLS
Seamless Pipe Fittings for Welding
★ Trade Mark Registered

TAYLOR FORGE & PIPE WORKS
General Offices and Works: Chicago, P. O. Box 485
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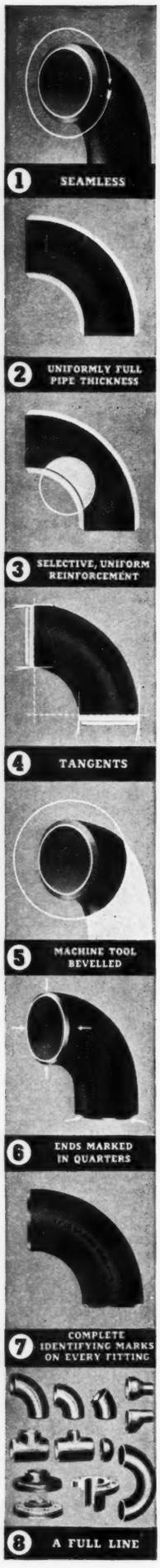
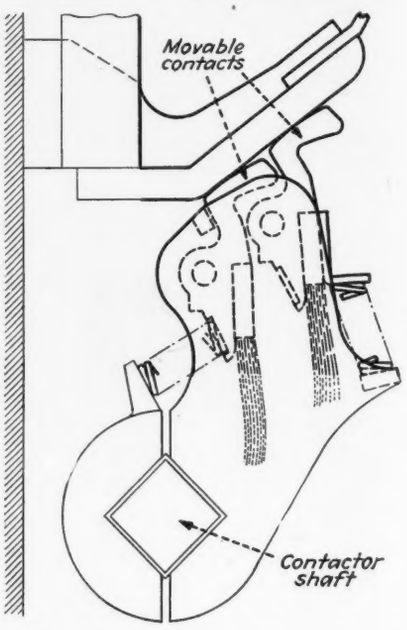

1 SEAMLESS
2 UNIFORMLY FULL PIPE THICKNESS
3 SELECTIVE, UNIFORM REINFORCEMENT
4 TANGENTS
5 MACHINE TOOL BEVELLED
6 ENDS MARKED IN QUARTERS
7 COMPLETE IDENTIFYING MARKS ON EVERY FITTING
8 A FULL LINE

contacts in tandem (see figure) so that top contact makes and breaks before lower contact. Final breaking of circuit takes place on upper-contact toe at point not used when closed. Current-carrying surfaces of contacts remain clean even after prolonged interrupting tests. Contactors actuated by vertical plunger solenoid, motion of which transferred to contactor shaft by toggle system that gives



maximum speed of contact opening and maximum contact pressure when closed. Rebound at end of opening travel positively prevented.

In 600-amp size, one pair of contacts is used and for 1,200-amp two pairs are used. Tests made at 550 volts 60 cycles, currents as low as 300 amp and as high as 1,200 amp have been interrupted in 0.53 to 1.4 cycles of arcing time by 1,200-amp equipment.

Monitor Controller Co, 51 S Gay St, Baltimore, Md.

High-Pressure Spray Hose

800-LB HOSE is constructed of high-grade tube that is said to resist deteriorating action of spray solutions. Composed of three braided plies of extra-wound yarn, and has cover of black abrasive-resisting stock. Available in sizes ⅜-, ⁷⁄₁₆- and ½-in. inside diameter. May be used for various requirements for various pressure services.

New York Belting & Packing Co, Passaic, N. J.

Sewage Ejector

"PACKAGE" pneumatic ejector, formerly built separately, now furnished with controls and compressor mounted on top of ejector receiver. No moving parts in ejector receiver, no stuffing-boxes, and no floats, bells, or air-storage tanks. Stationary electrode control provided, and all pipe and wiring connections between compressor and ejector, motor, and controls made at factory. Bulletin 4100.

Yeomans Bros Co, Chicago, Ill.

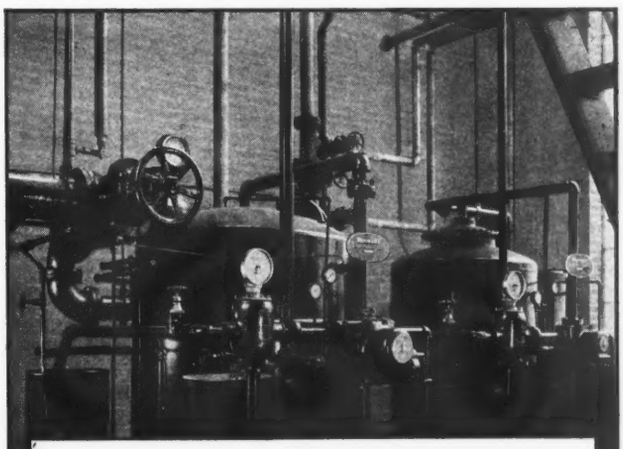
WRITE FOR YOUR COPY!
A "MUST" for your files!
AUTHORITATIVE! FREE!!
This 8-page illustrated booklet. Full story of Permutit Zeo-Karb, the feedwater treatment that's revolutionizing power plant water conditioning. Required reading for up-to-date engineers.
PERMUTIT
Zeo-Karb

IF the conversation turns to Zeo-Karb can you chime in? Do you know how it works, what it does? This booklet tells you.

You ought to know about Zeo-Karb—Permutit's latest success in feedwater treatment. It has the ability of zeolite to reduce hardness to zero. And in controlling alkalinity and reducing total dissolved solids it is better than Hot Lime Soda. It operates on either the hydrogen cycle (Zeo-Karb H, acid regenerated) or the sodium cycle (Zeo-Karb Na, salt regenerated). It's carbonaceous, non-siliceous, very resistant to low pH, and functions well on low hardness waters.

★ ★ ★

Write for your copy of the free Zeo-Karb booklet today. Address The Permutit Company, Dept. A, 330 West 42nd St., New York. No obligation, of course.



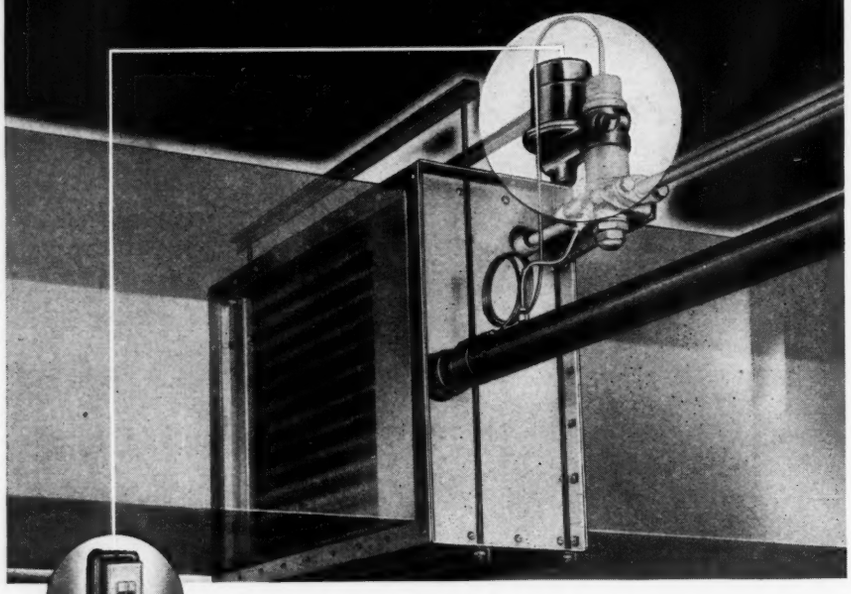
Zeo-Karb does all this by ion-exchange alone:

1. *Prevents Scale.* **2.** *Prevents Sludge.* **3.** *Inhibits Corrosion.* **4.** *Lowers Alkalinity.* **5.** *Reduces Total Dissolved Solids.* Illustration: installation in New Jersey power plant.

Permutit
The Water Conditioning Headquarters
over 25 years

ZEO-KARB • ZEOLITE AND ACID
HOT LIME SODA • LIME ZEOLITE • INTERNAL

NOW—UNIFORM AIRSTREAM TEMPERATURE
from Direct Expansion Coils



Here's how it's done
with simplified JOHNSON CONTROL

What it is—The *Johnson* "Modulating Attachment" is applied, in our factory, to any of several makes of thermostatic expansion valves, forming a single unit that is controlled by a distant thermostat as well as by the valve's own bulb. The expansion valve is installed as usual, with the thermostatic bulb strapped to the suction line to maintain the proper degree of superheat for maximum load conditions.

How it operates—When maximum cooling effect is not required, a *Johnson* airstream, room, or return air thermostat gradually throttles the valve, increasing the superheat in the coil and raising the airstream temperature . . . The bulb on the suction line operates normally, reducing the flow of refrigerant further, if necessary, to prevent liquid refrigerant from passing into the suction line.

Its advantages—This combined action is superior to starting and stopping the refrigeration compressor or operating a shut-off valve in the liquid line. Uniform temperature of the airstream leaving the coil! More dehumidification during periods of light load. Also, the *Johnson* "Modulating Attachment" acts as a stop-valve when the system is not operating. Two valves in one! Less labor during installation. Reduced maintenance costs . . . Ask a Johnson engineer to explain the details of this exclusive *Johnson* device.

Send for Bulletins V-301 to V-303.

ALSO: JOHNSON CONTROL FOR INDUSTRIAL PROCESSES

JOHNSON
Automatic TEMPERATURE AND AIR CONDITIONING Control

JOHNSON SERVICE COMPANY: MILWAUKEE, WIS. AND PRINCIPAL CITIES

Power Lines

(Continued from page 120)

ceeds Frank J Harrington, who has been transferred to the Sales Dept at the main office in Niagara Falls, N. Y.

WESTINGHOUSE ELECTRIC & MFG CO recently appointed R B Mildon and A C Streamer as special sales manager and general manager of East Pittsburgh Div, respectively. Mr Mildon was formerly general manager of the East Pittsburgh Div, and Mr Streamer in the past was manager of the Switchgear Div.

WM B SCAIFE & SONS, Pittsburgh, Pa., has established an industrial fellowship in Mellon Institute for the purpose of conducting scientific research on problems pertaining to processes of fabricating and the use of metal tanks, pressure cylinders, and water-softening equipment. Dr H L Anthony, III, is the present holder of this fellowship at the institute. He is a member of the American Society for Metals and has published results of investigations on coal and malleable castings. In his researches at the institute he will have the advisory collaboration on metallurgical and engineering specialists there and in the Scaife organization.

WICKWIRE SPENCER STEEL CO, and subsidiary, the American Wire Fabrics Corp, have removed general offices and eastern district sales office from 41 East 42nd St., New York, N. Y., to 500 Fifth Avenue, same city.

KORFUND CO, Long Island City, N. Y., has made DRAVO CORP, Pittsburgh, Pa., sole distributors, service managers, and installation agents of the Korfund anti-vibration products in western Pennsylvania.

METALLIZING ENGRG CO, INC, announce consolidation of general offices, new plant, and warehouse at 21-07 41st Ave., Long Island City, N. Y. R A Axline is president.

DELTA-STAR ELECTRIC CO, Chicago, Ill., have been awarded contract approximating $95,000 for 287,000-volt, 3-pole disconnecting switches for use on new transmission line of Los Angeles, Calif., Dept of Water and Power. Switches will be installed at Silver Lake and Victorville.

GREENE, TWEED & CO, New York, N. Y., announce removal of offices from 109 Duane Street, to 101 Park Ave, N. Y.

ASME and AIMME Plan Joint Meeting, Oct 5-7

A joint meeting of the Coal Division of the American Institute of Mining and Metallurgical Engineers and the Fuels Division of the American Society of Mechanical Engineers will be held in Columbus, Ohio, October 5-7.

R A Sherman, supervising fuel engineer at Battelle Memorial Institute, has been

(Continued on page 144)

Drop by drop go the profits—Drop by drop grows the puddle—a precious puddle caused by leakage.

But there's more than just waste involved. There's danger—for oil and gasoline waste constitute a fire hazard that must be instantly eliminated.

And BELMONT Petrola Sheet Packing does both . . . stops the waste—and eliminates the danger. With this Belmont Sheet on the job you make every drop of liquid *count*—turn losses into profits. That's why there are so many satisfied Belmont Sheet users—and that's why *you* should join them!

Call in the Belmont distributor on your next packing problem. He can supply any of the complete line of Belmont Sheet Packings. Built to satisfy the demands of practically every service—all will give the same on-the-job satisfaction as the Petrola Sheet illustrated and described on the right.

Stop building precious puddles NOW. Introduce yourself to Belmont Packings . . . the one sure way to stop waste.

BELMONT No. 650
Petrola Sheet Packing

Made of vegetable fibre sheet, treated with special chemicals. Exceptionally tough. Recommended against oils, gasoline, naphtha, benzine, kerosene, water, air, and gas, at all temperatures up to 325° Fahrenheit.

There is a complete line of Belmont Sheet Packings for every conceivable service.

Complete line of Belmont packings are stocked by authorized Belmont distributors in all important industrial centers.

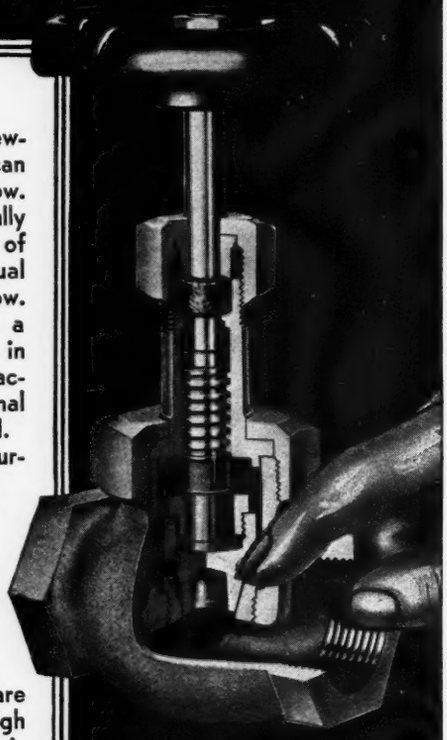
RIGHT: SAMPLE PAGE FROM THE NEW BELMONT CATALOG WHICH WILL BE OFF PRESS SOON

THERE'S A BELMONT PACKING FOR EVERY SERVICE

BELMONT
PACKINGS

THE BELMONT PACKING & RUBBER COMPANY
BUTLER AND SEPVIVA STREETS • PHILADELPHIA, PA.

Features that Appeal to Engineers



With the Fairbanks Renewable Plug Type Valve you can get a trickle or a normal flow. When opened from a fully closed position, each turn of the handwheel gives an equal enlargement of area for flow. Consequently, you can get a uniformly graduated increase in flow, which is important for accurate throttling; or a normal size flow when that is desired.

Due to the wide sealing surfaces in both the seat and disc and to the sharp angle of the plug, the stream flow is distributed so that it is never concentrated in one position. This reduces the possibility of erosion or wire drawing to a minimum.

Both seats and discs are made of nickel-alloy of high Brinnell hardness. The plug is ground into its own seat to insure a perfect fit. Seats and discs are renewable and can be replaced readily without removing the body from the pipe line.

You will find Fairbanks Renewable Plug Valves ideal for throttling, blow-off, boiler feed, drip lines and other severe services.

Write for our Catalog No. 21.

THE FAIRBANKS COMPANY
Valves, Dart Unions, Hand Trucks and Wheelbarrows
Executive Office:
397 Lafayette St., New York
Boston, Pittsburgh
Distributors in Principal Cities
Factories: Binghamton, N. Y., Rome, Ga.

Fairbanks Renewable Plug Valves

named chairman of the general committee for the meeting. Professor S R Beitler, of the Department of Mechanical Engineering, Ohio State University, is chairman of the local committee on arrangements.

Similar joint sessions of the two national engineering society divisions held last fall in Chicago and the previous year in Pittsburgh reported registrations of 300 or more. Plans for this year's meeting include two days of technical sessions, a morning of visits to industrial plants, and, by way of entertainment, the possibility of attendance at an Ohio State University football game the afternoon of the 7th.

Northwest and Powerton to Increase Capacity

Plans for the addition of 105,000 kw of capacity at Powerton Station near Pekin, Ill., and 90,000 kw at Northwest Station, were announced in April by James Simpson, chairman of Commonwealth Edison Co, Chicago.

The addition at Powerton will be ready for service in the fall of 1940 and at Northwest in the fall of 1941. The new units will increase capacity of the Commonwealth group of utilities to 2,150,000 kw. This compares with a peak load last winter of 1,477,000 kw.

More Power For Soviet Russia

From Soviet Russia comes the report that part of the third 5-year plan is the construction of two hydro plants on the Volga River to have a combined capacity of 4,556,000 hp. This project is part of a power, navigation and irrigation development involving eight dams and hydro stations all tied together to form one great hydroelectric development.

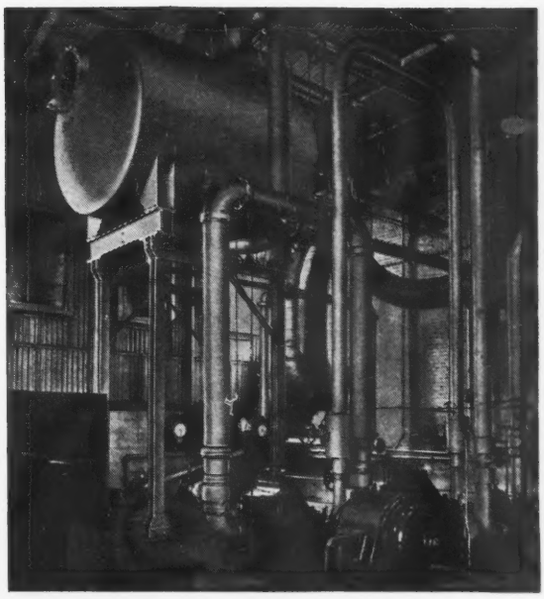
One of the plants, capacity 40,000 hp, is reported to be completed and two other projects, one with a capacity of 440,000 hp and another of 150,000 hp, are nearing completion. One of the larger dams to be built will require 15,600,000 cu yd of concrete and will form a reservoir three-fourths the size of Lake Ontario. Another plant is reported designed for seventeen 268,000-hp units, each turbine to weigh 2350 tons with a runner 32.8 ft in diameter. Large amounts of the power generated will be used to pump water to irrigate 7,500,000 acres of land.

Central Illinois Co Plans Steam Station

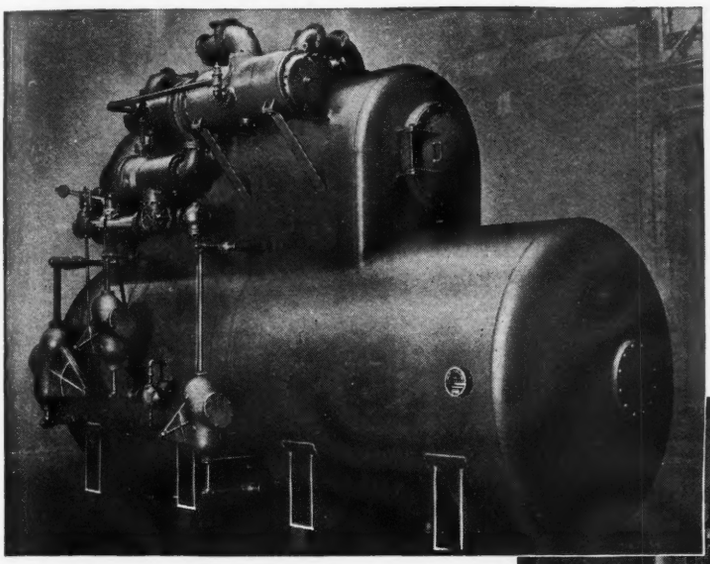
As part of a $3,500,000 program of construction, the Central Illinois Public Service Co plans a new 25,000-kw steam station, near Hutsonville, Ill, to be put in service in the spring of 1940. Building of the plant was scheduled to start early in May.

Designed for an operating steam pressure of 650 lb psi and 850 F, main equipment will consist of two high-pressure, high-temperature boilers of 15,000-lb-pr-hr capacity each, fired by twin pulverized-fuel

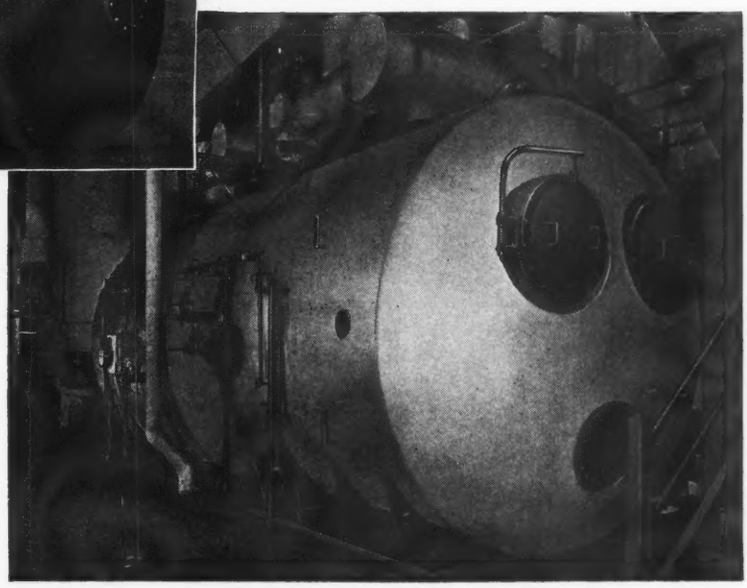
WORTHINGTON DEAERATORS REDUCE FUEL AND MAINTENANCE COST



IN A TEXTILE MILL. *This deaerator is for 176,000 lbs. per hour capacity. Note the two Worthington Centrifugal Boiler Feed Pumps for 550 p. s. i.*



IN A MANUFACTURING PLANT. *A 400,000 lbs. per hour capacity pressure-vacuum type storage unit. 7500 gallons storage capacity*



IN A LARGE CENTRAL STATION. *Two deaerators... capacity of each, 650,000 lbs. per hour*

FROM THE SMALLEST INDUSTRIAL PLANT TO THE LARGEST CENTRAL STATION WORTHINGTON DEAERATORS ARE BUILT TO MEET INDIVIDUAL PLANT REQUIREMENTS FOR LIMITED SPACE AND THE MOST EXACTING SERVICE CONDITIONS

PRODUCTS OF
WORTHINGTON
AIR CONDITIONING EQUIPMENT
REFRIGERATION AND ICE PLANT EQUIPMENT
AIR AND GAS COMPRESSORS
STEAM TURBINES
DIESEL ENGINES
GAS ENGINES
CONVERTIBLE GAS-DIESEL ENGINES
CENTRIFUGAL HIGH-PRESSURE BOILER FEED PUMPS
DIRECT-ACTING STEAM PUMPS POWER AND ROTARY PUMPS
DEEP WELL, SUMP, AND DRAINAGE PUMPS
STEAM CONDENSERS AND AUXILIARIES
VACUUM PUMPS
STEAM-JET EJECTORS
PORTABLE COMPRESSORS AND AIR TOOLS
For street, trench, conduit service
V BELT DRIVES LIQUID METERS

They will cut fuel costs by producing the maximum obtainable feedwater temperature. Further, by removing free oxygen and CO_2 they increase boiler efficiency, reduce boiler cleaning and repairs—and prolong the life of both boiler and piping.

Worthington engineers are available to study your feedwater problems. Get in touch with the nearest Worthington district office . . . today

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PRESSURE, VACUUM, PRESSURE-VACUUM, METERING, STORAGE
All Types . . . For Any Capacity

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ATLANTA, BOSTON, BUFFALO, CHICAGO, CINCINNATI, CLEVELAND, DALLAS, DENVER, DETROIT, EL PASO, HOUSTON, KANSAS CITY, LOS ANGELES, NEW ORLEANS, NEW YORK, PHILADELPHIA, PITTSBURGH, ST. LOUIS, ST. PAUL, SAN FRANCISCO, SEATTLE, TULSA, WASHINGTON

General Offices: HARRISON, NEW JERSEY

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REG. U.S. PAT. OFFICE

A MODERN LUBRICATED PACKING

Made of Long Fiber Asbestos and Lubricated for Modern Temperatures for STEAM, COMPRESSED AIR AND BOILER FEED WATER

A GENERAL SERVICE PACKING

TWIST FOR VALVES

SEND FOR ABC CHART OF PACKING SERVICES NO OBLIGATION ON YOUR PART

BRAIDED FOR RODS

GREENE, TWEED & CO.
SOLE MANUFACTURERS
101 PARK AVENUE, NEW YORK

burners. Main turbine-generator will be a 25,000-kva, 85%-power-factor, 13,500-volt tandem-compound condensing unit. Condensing water will be taken from the Wabash River through an intake crib and tunnels. Order for the 25,000-kva turbine-generators has already been placed with Allis-Chalmers Mfg Co. The plant will be constructed for a maximum flood level of 10 ft higher than has ever been recorded. Turbine and boilers will be in one large room, together with all operating equipment, with exception of circulating pumps and smaller miscellaneous equipment.

According to Chairman Purcell L Smith of the Middle West Corp, Chicago, parent company, cost of the Hutsonville plant will be divided over two years, approximately $1,750,000 being spent in 1939, the balance to be put on the Illinois Company budget for 1940.

Engineers' Books

Combustion

COMBUSTION, FLAMES AND EXPLOSIONS OF GASES (1st Edition—1938). *By Bernard Lewis and Guenther Von Elbe. Published by The University Press, Cambridge, England (Macmillan Co, New York, N. Y.) 415 pages 5x8½ in. 79 illustrations, 35 tables. Price $5.50.*

This authoritative work brings together much of the extensive data accumulated on the fundamental aspects of combustion, and should be of real value to specialists and to engineers who want to go beyond the simple and well-known combusion reactions. Most of the text is devoted to three phases of basic theory (1) chemistry and kinetics of the reactions between fuel gases and oxygen, (2) the propagation of flames, and (3) the state of the burnt gas. A section at the end is given over to a discussion of application of theory to engineering problems, with special reference to the internal-combustion engine.

SYMPOSIUM ON IMPACT TESTING (1938). *Published by American Society for Testing Materials, 250 South Broad St, Philadelphia, Pa. Price $1.25.*—Reviews material presented at the 1938 ASTM annual meeting, at which nine technical papers and discussions were given on fields of commercial use for impact tests. Reviews general consideration of impact testing problems.

SIXTH ANNUAL REPORT OF THE ENGINEERS COUNCIL FOR PROFESSIONAL DEVELOPMENT (1938). *Published by Engineers Council for Professional Development, 29 W 39th St, New York, N. Y.*—This booklet gives, among other data, a complete list of accredited engineering schools, including all engineering courses of colleges and universities which meet the standards set up by this body.

INDUSTRIAL INSTRUMENTS AND CHANGING TECHNOLOGY (1938). *Published by Works Progress Administration, National Research Project, 1734 New York Ave, N.W., Wash-*

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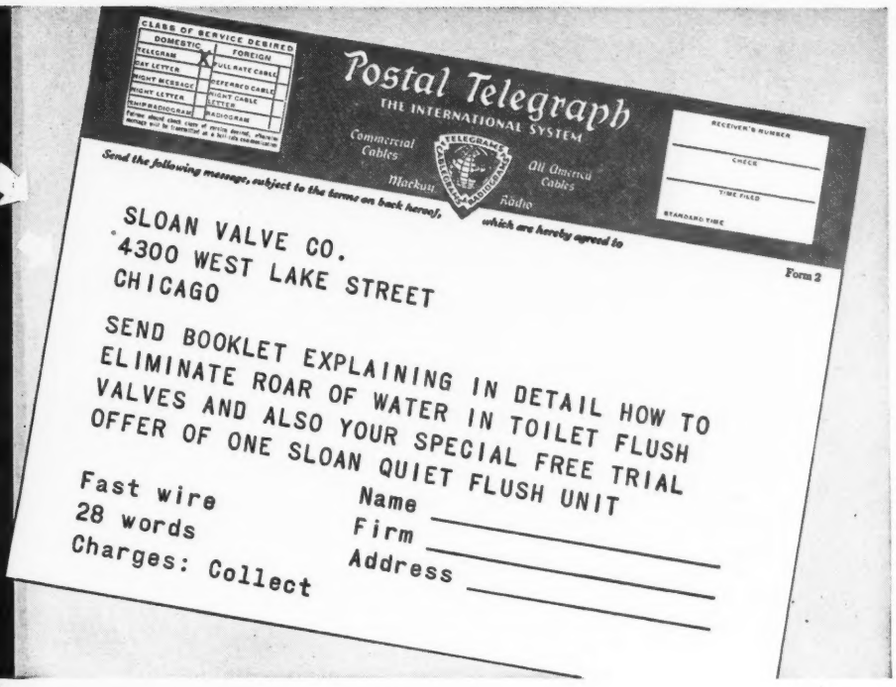

Silent Nights
HOTEL GUESTS, APARTMENT TENANTS, HOSPITAL PATIENTS DEMAND Quiet
WHY SHOULD FLUSH VALVES BE NOISY?
Your Present Equipment CAN Be Silenced Without Removing Fixtures
SLOAN VALVES

Clip this facsimile telegram blank—sign your name and address—ring for a Postal boy—and in a few hours a copy of "Silent Nights" will be on its way to you, air mail, with no cost or obligation.

Yes—it is that important. The tide of resentment against the needless roar of flush valves is mounting higher and higher. The noise is *so* annoying—and *so needless.* Now, regardless of what make of flush valve you have installed, the newly perfected Sloan *Quiet-Flush* equipment can materially reduce the roar. And if you have any one of the Sloan Royal, Star, Crown or Naval models—Sloan *Quiet-Flush* equipment will make your flush equipment valve *absolutely quiet*—and virtually a new installation.

But we are not asking you to take our word for this. We will *prove* Sloan *Quiet-Flush* equipment to you, in your own building, through a special introductory, free-trial offer. Wire for booklet "Silent Nights" and learn how you may test and prove Sloan *Quiet-Flush* to your own satisfaction. Wire today—and be your own judge.

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SLOAN *Quiet Flush* VALVES

"Call in.. 'The SCAIFE MAN'

HE KNOWS WATER TREATMENT . . .

—AND IT'S DOLLARS TO DOUGHNUTS HE CAN HELP SOLVE OUR BOILER FEED WATER PROBLEMS"

A safe wager, Gentlemen! THE SCAIFE MAN *can* help you unravel the costly tangle that develops in power plant operation when boiler feed water is at fault. His specialized knowledge is broad-based on experience with every type of plant—all conditions of water—and sound methods of treatment well-proved in practice.

Count THE SCAIFE MAN *in* on your next discussion . . . and you'll have at your elbow the feed water lore of a long-leading organization in the field of water treatment—entirely without obligation. We cordially invite you to make use of this service at any time!

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MANUFACTURES FOR THE POWER INDUSTRY:
Water Softeners: Hot Lime Soda... Cold Lime Soda... Sodium Zeolite.. Hydrogen Zeolite. Water Filters: Gravity... Pressure. Continuous Blowdowns; Zeolite Minerals; Filter Refills.
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ington, D. C. Price not stated.—Widespread use of measurement devices and automatic control instruments has speeded up production, improved quality of products, reduced costs and increased the productivity of labor. This booklet shows how and why.

TYPICAL MONTHLY BILLS FOR ELECTRIC SERVICE (1939). *Published by the Federal Power Commission, Washington, D. C. Price 10 cents.*—Report of electric rates, as of Jan 1, 1938, charged to residential, commercial light, commercial power, and industrial consumers of electric energy in cities of 50,000 population or more throughout the U. S. Rate data for 191 cities are presented in two groups, one for cities of 50,000 to 100,000 population, and the other for cities of 100,000 population and over.

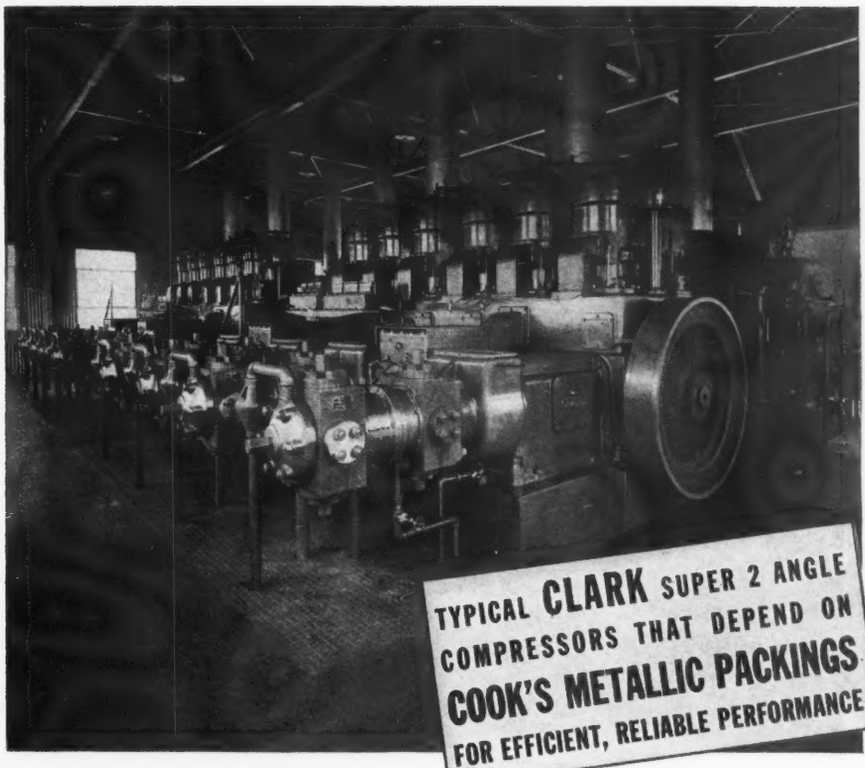
RATES, TAXES, AND CONSUMER SAVINGS (1939). *By the Federal Power Commission. Published by the U. S. Government printing office, Washington, D. C. Price $.15*—Report of the Federal Power Commission presents the result of three studies. (1) A comparison of the rates charged for electric service by publicly and privately owned utilities in 1935 and as of January 1, 1937. (2) A comparison of taxes, cash contributions, and free services furnished by the same to Federal, State, and local governments for the year 1936, and (3) a statement of estimated savings to consumers by reductions in rates of privately and publicly owned electric utilities during the period from July 1, 1935 to December 1, 1937.

KNOW YOUR ROPES (1938). *Published by Wickwire Spencer Steel Co, 41 E 42nd St, New York, N. Y. 82 pages, 7x10; illustrated; board covers. Available on request.*—A manual of wire-rope selection, application and usage tells how to make wire rope last longer. Covers proper methods of seizing ropes before cutting; condition of and sizes of sheaves; causes of wear on ropes; methods of installing sockets and other attachments; equalizing the loading on each rope in multiple-rope applications; rope stretch; types of ropes and their applications; proper handling of rope; recommended sheave diameters.

ASTM SPECIFICATIONS—(1939). *Published by the American Society for Testing Materials, Philadelphia, Pa. 135 pages, spiral binding, paperboard cover, price $1.25*—The ASTM Specifications in this booklet are for pipe and piping materials for high-temperature and high-pressure service. In the past, the ASTM has published these reports in pamphlet form, and this is the first issue in which the specifications have been made available for handy reference.

THE CORROSION OF METALS (1938). *By Oliver P Watts, Associate Professor Emeritus, in Chemical Engineering. Published by the Engineering Experiment Station, University of Wisconsin. 32 pages, 4 tables, paper bound, price. $.25*—This booklet presents views by the author, combined with experiments, on certain phases of corrosion. He gives the electrochemical theory of corrosion, Faraday's Law in Corrosion, and various types of corrosion, going from there into descriptions of those types. Results of experiments conducted are given.

50 YEARS MANUFACTURING EXCLUSIVELY METAL PACKINGS FOR PISTONS AND RODS



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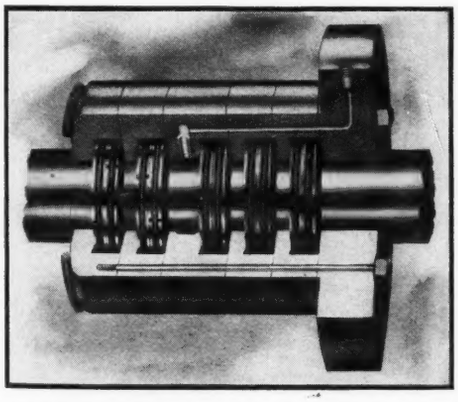

COOK'S Annular Cup Type Packing, shown above, is one of a complete line fitted with packing rings of exclusive design and materials that impart longer ring life—provide maximum seal—eliminate rod scoring. There is a proven style of COOK'S Packing for all engine and compressor service requirements.

YEAR after year—24 hours a day—COOK'S 3000# Metallic Rod Packings play a big part in assisting these Clark gas engine driven compressors to operate at **maximum efficiency with minimum expense.** The choice of leading manufacturers and operators for over 50 years, COOK'S Packings have **unequalled sealing properties and long life.** They reduce friction to a mere fraction—keep rods like new—defer maintenance expense for years—and they have proven so superior in every way that COOK'S Packings are the accepted standard in all branches of industry where operating conditions demand the best. Many modern engines and compressors are delivered factory equipped with COOK'S Packings—others come COOK equipped on request.

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When you order new equipment, make sure you get the genuine by **specifying COOK'S Metallic Packings by name.** For equipment in service, order COOK'S Packings from your engine builder or consult us direct.

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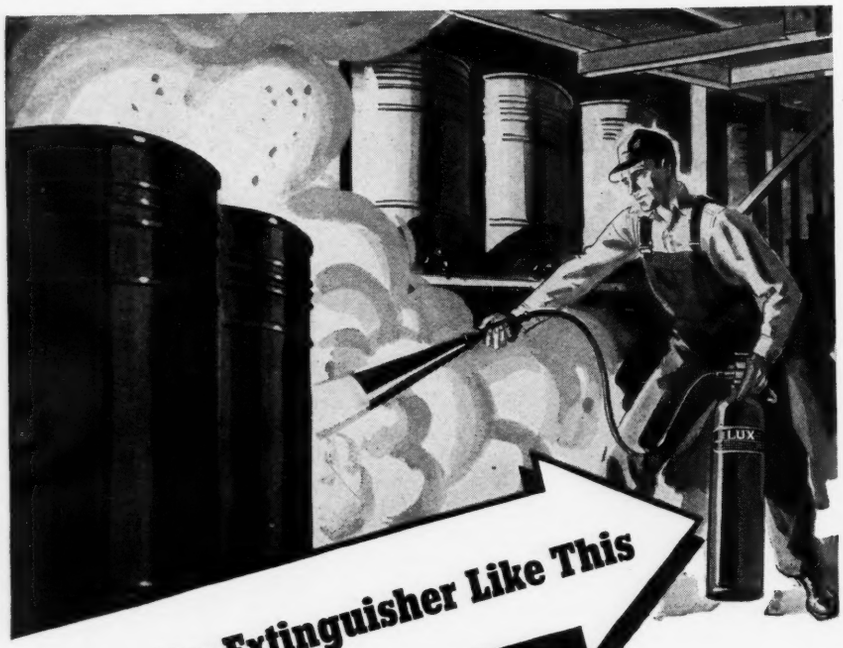
ARM AGAINST FIRE—



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Industry selects Lux protection for the excellent reason that Lux is the kind of fire-fighter industry needs.

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STRAWS

Pointing the way business winds blow

ARIZONA——Dept of Interior, Indian Service, Washington, D. C., contracted Lewis Bros, 2946 North Third St, Phoenix, for central-heating and power plant at Navajo Indian Agency, Fort Defiance, at $106,352, including two high-pressure boilers, with stokers and combustion-control equipment, coal-handling equipment, water-softening apparatus, and 75-kw generator unit.

Phoenix Union High School and Junior College Dist, Phoenix, contracted C O Johnson, 946 East Berkeley Rd, Phoenix, for central-heating plant at junior college. Cost about $90,000. Lescher & Mahoney, Title & Trust Bldg, Phoenix, architects.

CALIFORNIA——Bureau of Yards and Docks, Navy Dept, Washington, D. C., plans power plant at naval training-station, San Diego. Appropriation of $50,000 being arranged.

Best Foods, Inc, 1900 Bryant St, San Francisco, plans 3-story addition to cost about $100,000. Kaj Theill, 580 Market St, engineer. Main offices of company are at 88 Lexington Ave, New York, N. Y.

Arden Farms, Inc, Fresno, plans ice and refrigerating plant in local creamery and ice cream plant at L and San Diego Sts. Cost about $75,000. Webber & Nelson, Hollingsworth Bldg, Los Angeles, architects.

Imperial Irrigation Dist, El Centro, will award contract soon for addition, 48 x 70 ft, to diesel-electric plant at Brawley, including fuel tanks.

Ryan Aeronautical Co, San Diego, plans 1-story aircraft-manufacturing plant, 200 x 275 ft, on site adjoining U. S. Coast Guard air base. Cost about $100,000 with power equipment. Edward C and Ellis W Taylor, 803 West Third St, Los Angeles, architects.

Henry J Kaiser Co, Latham Sq Bldg, Oakland, engineering contractor, plans large cement mill in Permante Canyon district, Santa Clara County, to furnish cement for Shasta dam of Federal Government, for which company is scheduled to secure award totaling about 5,800,000 bbl. Mill will comprise several large production units and power house and pumping station will be built. Cost close to $3,500,000.

COLORADO——Denver Market & Produce Terminal, 619 Equitable Bldg, Denver, recently organized, plans large market and produce terminal on site bounded by 9th and 12th, Wazee and Walnut Sts, consisting of 1-story units, with power house, cold-storage and refrigerating plant, rail loading and distribution facilities. Cost about $1,000,000.

Correll Candy Kitchen, Monte Vista, John Correll, head, plans cold-storage and refrigerating plant on local site at Adams St, and 3rd Ave, with about 350 locker units. Cost reported close to $40,000.

Bureau of Reclamation, Denver, contracted Allis-Chalmers Mfg Co, at $1,843,-200 for turbine units for hydroelectric plant at Shasta dam, Central Valley Project, Calif.; also made award to James Leffel & Co, Springfield, Ohio, at $68,055 for two station-service turbines and two station-service governors, same project.

Colorado State Bd of Agriculture, Denver, will award contract soon for improvements in power house at Fort Collins, Colo., including additional equipment. Cost about $60,000. Frewen & Morris, Midland Savings Bldg, Denver, architects.

CONNECTICUT——Chandler-Evans Corp, 2200 Eighth St, Detroit, Mich., manufacturer of aircraft-engine equipment, carburetors, etc, plans 1-story branch plant, 100 x 143 ft, at Meriden, where tract of land has been acquired. Cost estimated at $100,000.

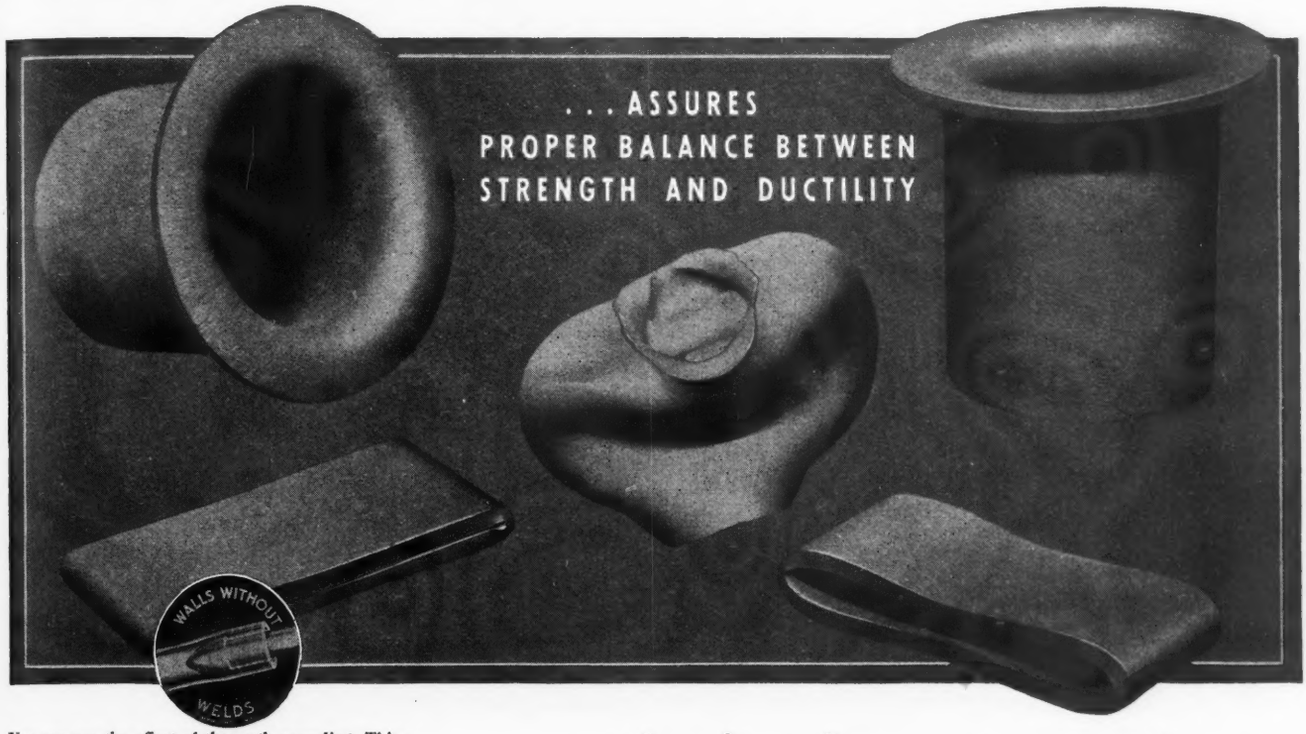
International Silver Co, Meriden, contracted H Wales Lines Co, 134 State St, for boiler house at local plant. Equipment awards will be made separately. Cost reported about $35,000.

New England Ice Co, 221 Hallam St, Bridgeport, let general contract to H G Bengston & Co, 303 Walkelee Ave, Ansonia, for 1-story ice-manufacturing plant on Howard Ave, Ansonia. Cost reported about $50,000.

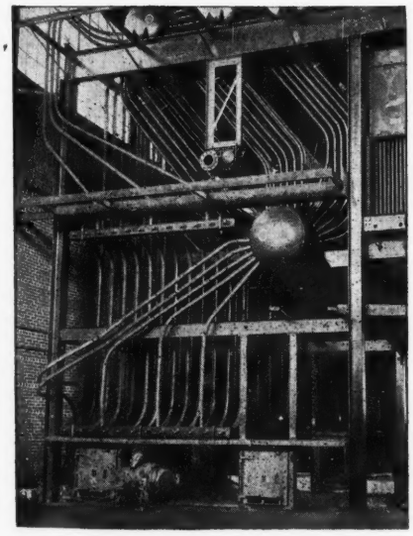
FLORIDA——Growers' Cold Storage Corp, 1200 N W 22nd St, Miami, plans 1-story cold-storage plant, 80 x 150 ft. Cost about $40,000. Pfeiffer & Pitt, 35 S E 1st Ave, architects.

GEORGIA——J C McAuliffe, 796 Wilson Rd, N W, Atlanta, and associates, plan boiler house at distillery on Milton Ave, S W. Cost close to $90,000. A Thomas Bradbury, William-Oliver Bldg, architect.

Every Tube 100% Annealed!



You can see the effect of thorough annealing. This process gives NATIONAL Seamless Boiler Tubes the proper ductility so they can be flanged, flattened, crushed, or otherwise deformed without developing flaws or splits. That's why boiler makers can install them faster, and why once installed, they give added assurance of trouble-free operation.



Standard equipment in many of America's largest, most important steam-generating units, NATIONAL Seamless Boiler Tubes have earned an enviable reputation for reliability. Consistently uniform in steel quality, wall strength, and workability.

. . . that's why you save time and money with

NATIONAL SEAMLESS

BOILER makers report that they save 15 to 20 per cent of installation time by using NATIONAL Seamless Boiler Tubes.

Because every tube is completely annealed at the mill, before shipment, these tubes set, expand, roll, and bead easily. This controlled annealing operation added to expert craftsmanship through every stage of production, results in a tube that is ideal for boiler service.

It has better creep strength and superior heat transfer characteristics, because only killed open-hearth steel is used. It is flawless, because it has survived the piercing process, the severest commercial test of steel quality ever devised. And it is seamless, which means full wall strength throughout, "Walls Without Welds."

That's why NATIONAL Seamless Boiler Tubes help boiler makers produce better, safer, more trouble-free installations. Use these tubes and you'll find them good for consistent, long-life service. Write for Bulletin No. 12, which contains complete data.

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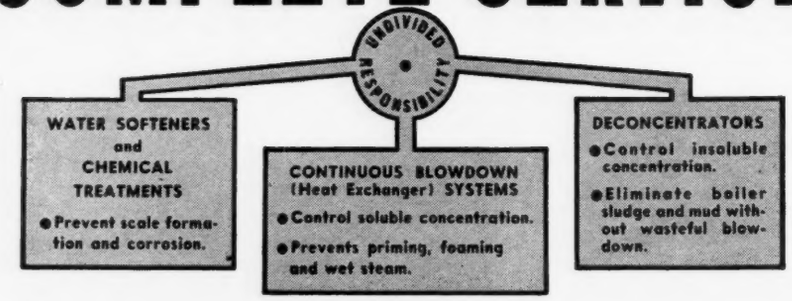
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WATER SOFTENERS and CHEMICAL TREATMENTS
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● Control soluble concentration.
● Prevents priming, foaming and wet steam.
DECONCENTRATORS
● Control insoluble concentration.
● Eliminate boiler sludge and mud without wasteful blowdown.

Solves your boiler water problem and KEEPS it solved

"SUCCESS", said the head of one of the world's most successful businesses, "is simply a matter of choosing the right man for the job and giving him full charge." When you choose Elgin to solve your boiler water conditioning problem, you choose an organization that has proved its ability to solve the problem and *keep* it solved. Here's why:

● **A BETTER SURVEY OF THE NEEDS.** More than thirty years of experience have shown us the vital importance of *being sure of our facts* before recommendations are made.

● **UNPREJUDICED RECOMMENDATIONS.** To properly solve a boiler water conditioning problem, the boiler water treatment must be fitted to the plant—never the plant fitted to the treatment. Since Elgin can supply any type of internal treatment, or choose a water softener from the many highly developed Elgin Softeners, you can be sure that the Elgin recommendation is *unbiased* and *correct*.

● **PLUS FACTOR OF CONCENTRATION CONTROL.** More than any other organization, Elgin has recognized the importance of going beyond mere water treatment. Only Elgin has the "Deconcentrator" for eliminating boiler sludge and mud without wasteful blowdowns in plants where water carries insoluble concentration. The Elgin Continuous Blowdown Heat Exchanger System solves the same problem equally well where boiler water carries soluble concentration.

● **BETTER INSTALLATIONS.** Elgin erecting engineers install properly and give instructions for correct operation, with simplified testing equipment. This is vital to success.

● **REGULAR CHECK-UPS.** Our service engineers inspect jobs regularly to keep the Elgin System operating at highest efficiency. In addition, a complete *Consulting and Laboratory Service is provided continuously to Elgin Users*—never forget that.

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Company_____
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Public Buildings Branch, Treasury Dept, Washington, D. C., plans central-heating plant in multi-story postoffice garage building at Atlanta. Appropriation of about $285,000 has been arranged. Bids will be asked soon.

ILLINOIS——River Forest Garden Apartment Corp, 5510 South Cornell Ave, Chicago, plans central-heating plant in 3-story apartment houses at River Forest. Cost about $750,000. Holsman & Holsman, 140 South Dearborn St, Chicago, architects.

Chicago Flexible Shaft Co, 5600 West Roosevelt Rd, Chicago, has filed plans for 2-story addition, 46 x 336 ft. Cost about $100,000 with machinery and power equipment. Olsen & Urbain, 228 North LaSalle St, architects.

State Dept of Public Buildings, Springfield, will award contract soon for addition to power house at State hospital, Dixon. Equipment awards will be made separately. Division of Architecture & Engineering, C Herrick Hammond, state supervising architect, Springfield, in charge.

INDIANA——Allison Engrg Co, Speedway City, Indianapolis, manufacturer of aircraft motors and parts, a subsidiary of General Motors Corp, Detroit, Mich., plans addition to plant, totaling about 200,000 sq ft of floor space. Cost close to $2,000,000. Work will begin soon.

Rushville will place contracts soon for equipment for boiler department at municipal steam-electric plant, including two 90-gpm turbine-driven boiler-feed-pumps, one motor-driven water-service pump, extension in ash-conveyor system, combustion-control equipment, boiler room instruments, piping and accessories, cooling tower, etc. This is part of improvements at plant to cost about $180,000. Bevington-Williams, Inc, Indiana-Pythian Bldg, Indianapolis, consulting engineer.

Matthews plans pumping station for new waterworks system, with 200-gpm turbine pumping unit, and 75,000-gal. elevated steel tank and tower. O T Hancock, Plainfield, consulting engineer.

Richmond is considering extensions in municipal power plant, including 15,000-kw turbine-generator unit. W R Stevens is station superintendent.

Fort Wayne will award contracts soon for improvements in municipal power plant, including new equipment. Cost about $47,000.

Medora plans installation of deepwell pumping machinery, 50-000-gal. elevated steel tank and tower, and other mechanical equipment for water system. Election to approve bond issue of $60,000 is being arranged.

IOWA——Bd of Muscatine County Commissioners, Muscatine, plans improvements in county central steam-heating plant, including additional equipment. Cost reported about $40,000. Howard S Muesse, Davenport Bank Bldg, Davenport, architect.

Renwick awarded contract to Fairbanks, Morse & Co, Omaha, at $24,150 for furnishing and installing 300-hp diesel generating unit with exciter and building changes.

J J Hogan, Jr, and Lloyd Simmons, Marengo, have taken over a local building and will remodel and equip for cold-storage plant, with locker system. Cost reported about $35,000.

State Bd of Education, Des Moines, will award contract soon for steam turbine-generating unit for power house at State Teachers' College, Cedar Falls.

Bd of Linn County Commissioners, Cedar Rapids, will award contract for 1-story cold-storage and refrigerating plant. Cost reported about $30,000, with equipment.

R A Bartlett, Whittemore, heads project to construct and operate a local cold-storage plant, with locker system. Company will be organized to carry out development. Cost reported about $35,000.

Villisca contracted Fairbanks, Morse & Co, Chicago, for 875-hp diesel generator unit at $69,113, for municipal electric plant. Awards for other equipment will be made soon. A S Harrington, Baum Bldg, Omaha, Neb., consulting engineer.

Woodbine, has approved bonds for $115,000 for new municipal power plant, for which plans will be drawn and bids asked. Proposed to install diesel generator units.

Ottumwa Gas Co, Ottumwa, plans pressure pipelines for natural-gas transmission and distributing systems. Cost estimated close to $75,000.

KANSAS——Bd of Education, Salina, plans central-heating plant in 3-story and basement senior high school. To begin work this summer. Cost about $600,000. Benjamin H Byrnes, National Bank of America Bldg, and Charles W Shaver, United Life Bldg, both Salina, associated

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"Sorry to spoil the scenery, officer, but I feel like Christopher Columbus after this little egg trick. I've discovered a motor oil that proves its case by PERFORMANCE. I never believed any oil could make that much difference in my car ...and that fast. What's the name? RING-FREE! If I were you I'd try it in that motorcycle. It will certainly speed up your service-record!"

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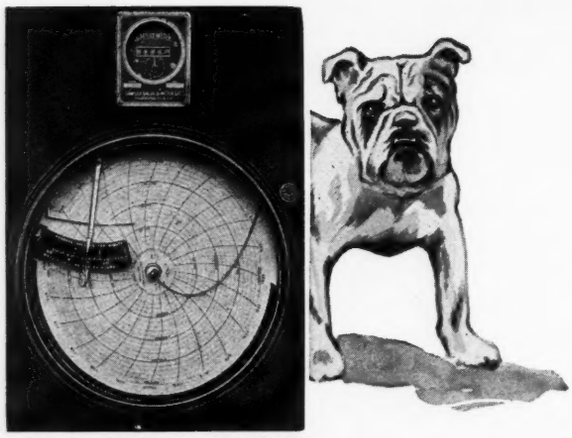

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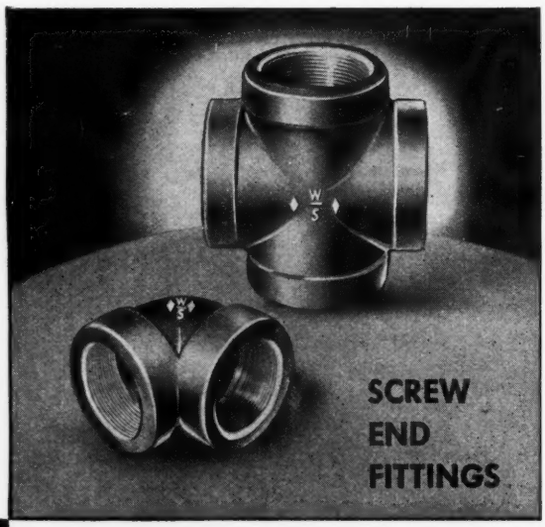

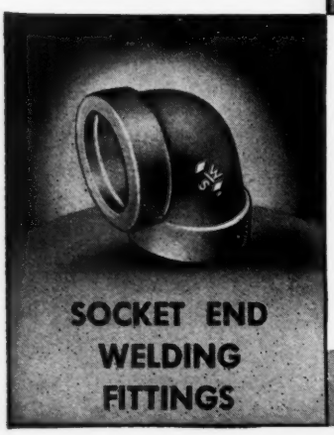

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WATSON-STILLMAN

architects; Engineering Service Co, Railway Exchange Bldg, Kansas City, Mo., mechanical engineer.

Ottawa recently awarded contract for cooling tower and other improvements at municipal light and power plant to the Marley Co, Kansas City, at $40,380.

Chanute plans water-softening plant for municipal water system, including 4 chemical-feed machines, and settling tanks. Bond issue of $40,000 has been authorized. R B Reeves, city engineer.

Bd of Public Utilities, Kansas City, contracted De Laval Steam Turbine Co, Trenton, N. J., for pumping machinery, with capacity of 25,000,000 gal. per day, for installation in Quindaro waterworks station. Burns & McDonnell Engrg Co, 107 West Linwood Blvd, Kansas City, Mo., consulting engineer.

KENTUCKY——Owensboro will award contracts for equipment for addition to municipal electric plant, including 7500-kw turbine-generator unit, surface condenser, circulating-water pumps, feedwater pumps, switchgear and accessory equipment. Award for building erection has been let to Engstrom & Wynn, 1117 Chapline St, Wheeling, W. Va. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

Corbin awarded contract for improvements to municipal light and power and water plant to J F Pritchard & Co, Kansas City, Mo., at $65,762. Bids were opened April 18th.

State Bd of Education, Frankfort, has low bid from Williams & Arnold, Inc, Louisville, for erection of boiler house at State Industrial College, at $21,560, exclusive of equipment, and will make award soon. Cost about $75,000 with boiler units. Leo Oberwarth & Sons, West Second St, Frankfort, architects.

State Welfare Dept, Frankfort, plans central-heating plant at State Hospital near Danville, consisting of several large buildings. Bids will be asked soon. Fund of $2,500,000 has been arranged for entire project. Associated Architects, Washington Bldg, Louisville, architects.

LOUISIANA——Southern Pacific Railroad Co, Houston, Tex., plans air-conditioning plant and system in Union Station at Shreveport, to be carried out jointly with Illinois Central System, Chicago, Ill., and Louisiana & Arkansas Railway Co, Shreveport. Cost about $250,000.

Southern Cotton Oil Co, Canal Bank Bldg, plans cottonseed oil mill at Natchitoches, where site has been purchased, including several 1-story units, with boiler house. Cost reported close to $100,000.

Standard Oil Co of Louisiana, Continental Bank Bldg, Shreveport, plans welded steel pipeline from Magnolia and Village oil-field areas, Columbia County, Ark., to Haynesville, about 35 miles, for crude oil transmission, making connection with company system at Haynesville. Pumping stations will be installed along route for booster service. Cost close to $250,000.

MARYLAND——Bata Shoe Co, 2704 West North St, Chicago, Ill., plans large factory at Belcamp, where tract of 2000 acres of land has been purchased, to consist of several 1-story units. Power house will be built. Cost over $500,000. Company also will carry out housing development for plant employes, consisting of 50 dwellings. Proposed to begin work in June. Joseph Polasek, company architect.

Bd of Washington County Commissioners, Hagerstown, plans central-heating plant in 5-story county court house. Cost about $600,000. Bond issue is being arranged. Frederick L W Moehle & Associates, 409 North Charles St, Baltimore, architects.

Bd of Directors, Cheltenham State School for Negro Boys, Cheltenham, plans addition to power house at institution, with new equipment. Fund of $85,000 has been authorized for this and mechanical laundry building. Proposed to begin work soon.

MASSACHUSETTS——Boston Housing Authority, 10 Oliver St, Boston, John Breen, chairman, plans central-heating plant in housing development at Kendall and Lenox Sts, South End district, comprising group of 9 3-story buildings. Bids will be asked soon. Cost about $2,000,000. Maginnis & Walsh, 20 Providence St, Boston, architects.

Construction Service, Veterans Administration, Washington, D. C., will receive bids until June 6 for power house at institution at Bedford, including boiler units.

Draper Corp, Hopedale, contracted Bathelt Const Co, 6 Newton St, Holyoke, for 1-story addition to textile machinery-manufacturing plant. Cost about $50,000 with mechanical and power equipment. McClintoch & Craig, 458 Bridge St, Springfield, architects.

Boston Housing Authority, 10 Oliver St, Boston, John Breen, chairman, plans cen-

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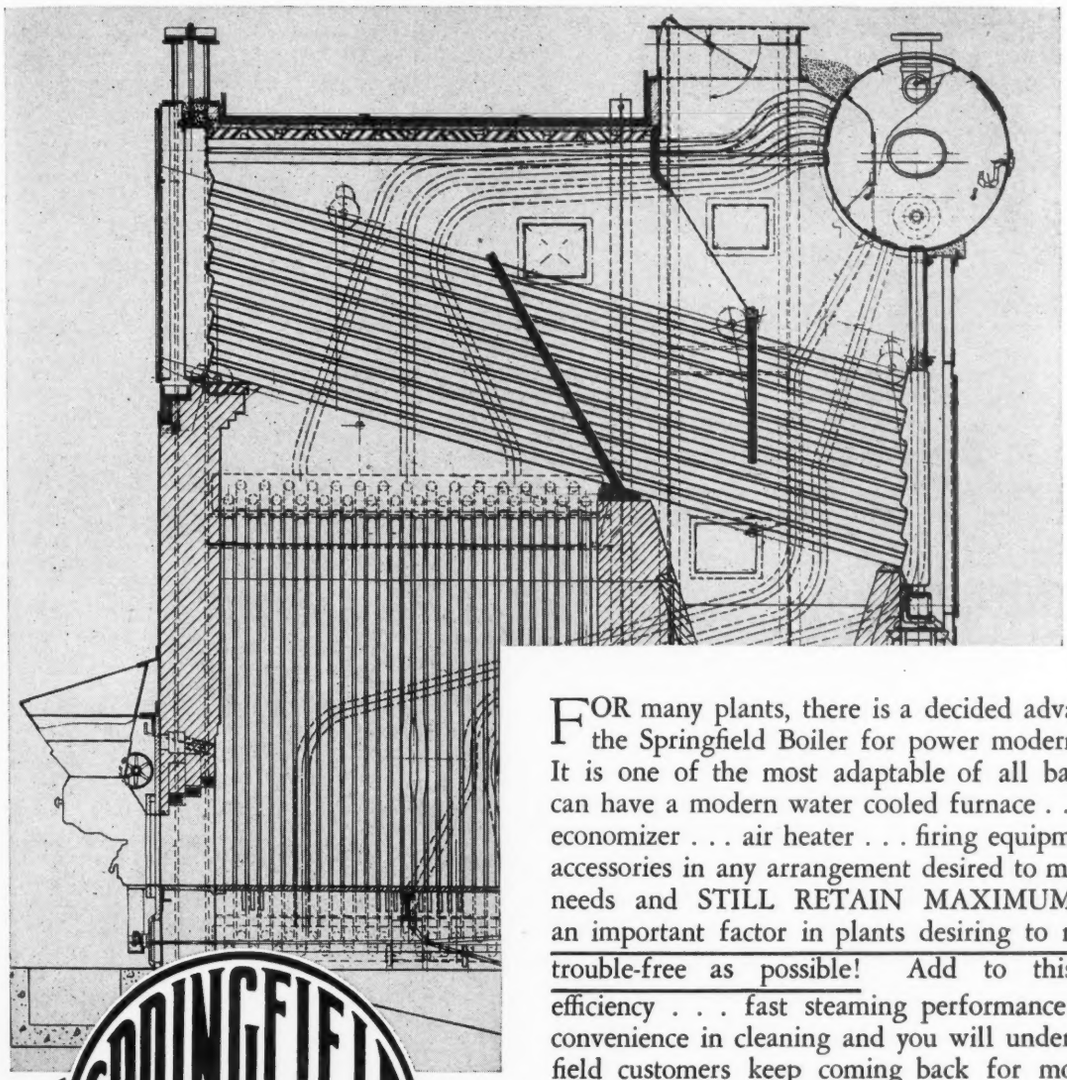

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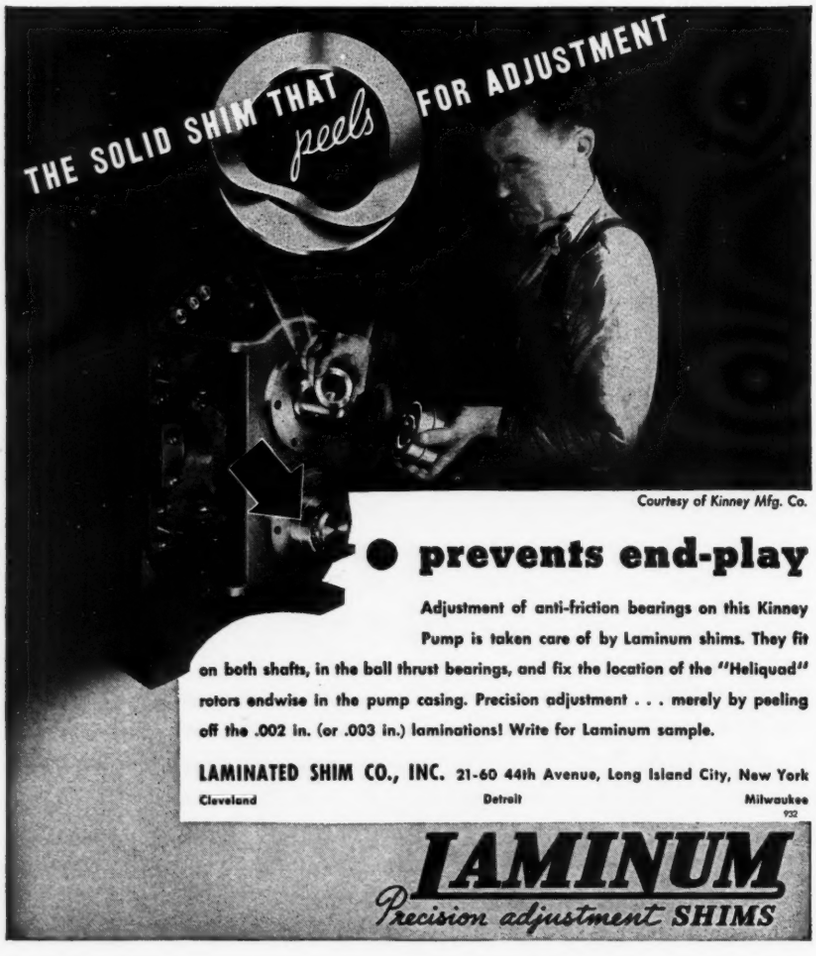

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LAMINUM
Precision adjustment SHIMS

tral-heating plant at housing development in Charlestown district. Cost about $6,000,000. Bids will be asked in June. John M Gray, 175 High St, architect, and Richard D Kimball Co, 6 Beacon St, heating and electrical engineer, both Boston.

MICHIGAN——Grand River Oil Co, Grand Rapids, recently organized to take over Imperial Refining Co, Grand Rapids, plans power house and pumping-station at new oil refinery in Wyoming Township, near city, where site has been purchased. Entire plant will cost about $150,000. Albert H Hickey, Alma, vice-president and general manager.

MacKenzie Manor Housing Corp, Detroit, care of Charles N Agree, Book Tower Bldg, architect, plans central-heating plant at new local housing development. Cost estimated about $500,000. Work scheduled to begin soon.

Public Buildings Branch, Treasury Dept, Washington, D. C., plans central-heating plant in new multi-story post-office garage and service building at Marentette and 14th Sts, Detroit. Cost about $700,000. Appropriation has been arranged and bids are scheduled to be asked soon.

MINNESOTA——Preston plans municipal power plant, using diesel generating units and accessories. Special election has been called to vote bonds for $45,000. Engineer will be selected to make sulveys and plans.

Pen-O-Tex Oil Co, Plymouth Bldg, Minneapolis, plans bulk oil-storage and distributing plant near Washington Ave bridge, on Mississippi River waterfront, including pumping station, steel tanks with capacity of 6,000,000 gal., pipelines and other facilities. Cost about $200,000.

Worthington will award contracts soon for improvements in municipal power plant, including turbine-generator unit, condenser, switchgear, etc. Ralph D Thomas, 1200 Second Ave, South, Minneapolis, consulting engineer.

Independent School District No. 27, Hibbing, plans installation of stoker and auxiliary equipment in power house at school at Brooklyn. Financing is being arranged. S A Patchin, superintendent of schools.

MISSOURI——State Building Commission, Bi-Partisan Advisory Bd, Edgar M Eagan, executive secretary, Merchants Bank Bldg, Jefferson City, will take bids soon for improvements in boiler house at state prison, including additional equipment. Cost close to $100,000. Will also ask bids for equipment for diesel generating plant at local auxiliary state prison, to cost about $50,000. Baumes Engrg Co, Railway Exchange Bldg, St. Louis, consulting engineer.

Kirkwood awarded contracts for municipal electric substation and equipment as follows: Section 1, switchboard, to S E Killebrew, 1047 Big Bend Blvd, Richmond Heights, St. Louis, at $2,373; Section 2, transformers, switchgear, lighting system and building to S C Sachs Co, 817 North 9th St, St. Louis, at $57,900, and Section 3, voltage regulators for substation to S C Sachs Co at $3,430.

U.S. Engineer's office, 816 U.S. Court House and Custom House, received bids May 5 on construction of power, control and lighting system for Lock and Dam No. 24, Mississippi River, at Clarksville.

Bd of Education, St. Louis, contracted Sodeman Heat & Power Co. 2306 Delmar Blvd, at $63,263 for installation of air-conditioning plant and system in Bd of Education building.

Pleasant Hill contracted Worthington Pump & Machinery Corp, at $91,531 for 3 diesel generator units, with total capacity of 1000-hp, for municipal power plant. W B Rollins & Co, Railway Exchange Bldg, Kansas City, consulting engineers.

NEBRASKA——David City contracted Murray Iron Works, Burlington, Iowa, for 250-lb boiler unit and accessories, for municipal power plant. Also made award to Detroit Stoker Co, Detroit, Mich., for stoker and auxiliaries. Cost about $36,400. C Robert Fulton, 2327 South 19th St, Lincoln, consulting engineer.

NEW HAMPSHIRE——Rumney, through authorization by voters, will construct municipal electric power and light plant.

Plymouth has appointed committee to investigate advisability of purchasing municipal electric power plant.

NEW JERSEY——Hills Brothers Coffee, Inc, 2 Harrison St, San Francisco, Calif., plans power house at branch coffee-roasting and blending plant at Edgewater, where large tract of land has been acquired. Will consist of several multi-story units, totaling 225,000 sq ft of floor space. Cost reported over $650,000. Austin Co, 16112 Euclid Ave, Cleveland, Ohio, engineer and contractor.

NEW MEXICO——Joseph Land, Albu-

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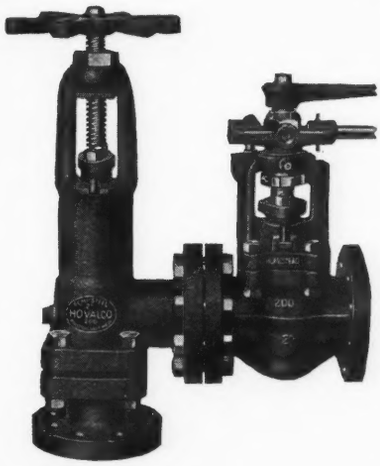

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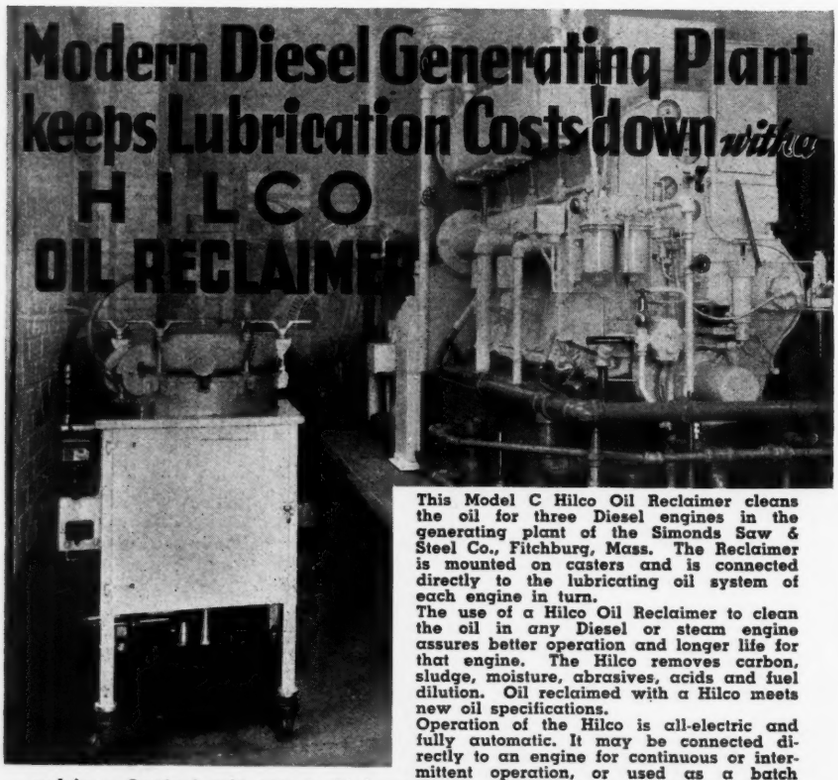
BRANCHES: CHICAGO, ST. LOUIS, SAN FRANCISCO

Modern Diesel Generating Plant keeps Lubrication Costs down with a HILCO OIL RECLAIMER



This Model C Hilco Oil Reclaimer cleans the oil for three Diesel engines in the generating plant of the Simonds Saw & Steel Co., Fitchburg, Mass. The Reclaimer is mounted on casters and is connected directly to the lubricating oil system of each engine in turn.

The use of a Hilco Oil Reclaimer to clean the oil in any Diesel or steam engine assures better operation and longer life for that engine. The Hilco removes carbon, sludge, moisture, abrasives, acids and fuel dilution. Oil reclaimed with a Hilco meets new oil specifications.

Operation of the Hilco is all-electric and fully automatic. It may be connected directly to an engine for continuous or intermittent operation, or used as a batch reclaimer. Serviced only once in 24 hours. Users report savings of 50% to 75% on lubrication.

A HILCO WILL REDUCE YOUR MAINTENANCE COSTS

Let a Hilliard engineer show you what savings can be made in your plant. Write for complete information and booklet "Oil Reclamation," describing the operation of Hilco Oil Reclaimers in detail.

THE HILLIARD CORPORATION

4 West 4th Street — See Hilco Booth 17, at Ann Arbor A.S.M.E. Oil and Gas Power Conference June 19-22 — ELMIRA, N. Y.

querque, formerly head of Nehi Bottling Works, Albuquerque, plans 1-story ice-manufacturing and cold-storage plant on local site at New York Ave and Broadway. Cost about $65,000.

NEW YORK——Great Lakes Carbon Corp, 30 Rockefeller Plaza, New York, plans new plant at Niagara Falls, for production of carbon-electrodes, graphite-electrodes, etc, on 15-acre tract of land at Pine Ave and 56th St. Power house will be built. Cost over $175,000. B E Broadwell, Lewiston, engineer.

Newark has authorized surveys and estimates of cost for new municipal power plant. Engineer will be engaged for this purpose.

Sheffield Farms Co Inc, has completed alterations in pasteurizing and bottling plant at 1380 Fulton St, Brooklyn. Improvements include installation of FlakIce equipment and corkboard insulation. Work planned and carried out by Sheffield Farms Engrg Dept, under direction of C Hammond and E H Paulsen.

NORTH CAROLINA——High Point contracted Baldwin-Southwark Co, Eddystone, Philadelphia, Pa., for 3 hydraulic turbines and governors, for municipal hydroelectric plant on Yadkin River, at $268,930. 3 electric-generator units, capacity 30,000-hp, will be furnished by Allis-Chalmers Mfg Co, at $292,100. Entire project will cost $6,492,000. Financing has been arranged through Federal aid. Murray & Flood, Inc, 369 Lexington Ave, New York, N. Y., consulting engineer.

Bd of Directors, Goldsboro State Hospital, Goldsboro, will award contracts soon for power plant equipment for installation at State Hospital, including boiler units, coal-handling equipment, piping, etc. Atwood & Weeks, Inc, Southern Fire Insurance Bldg, Durham, architects and engineers.

OHIO——A E Staley Mfg Co, Decatur, Ill., manufacturer of starch, oils, etc, plans branch plant for soy-bean-processing near Painesville, where tract of land has been secured, consisting of several units, including power house. Cost about $300,000.

Lancaster is considering welded-steel pipeline from city limits to gas-field district near Corning, about 40 miles, for natural-gas transmission for local distribution. Estimates of cost will be made.

East Liverpool contracted Dravo Corp, Neville Island, Pittsburgh, Pa., at $35,870 for pumping plant for municipal water system, including pumping units.

Piqua will award contracts soon for miscellaneous equipment for municipal power plant. Burns & McDonnell Engrg Co, 107 West Linwood Blvd, Kansas City, Mo., consulting engineer.

SOUTH CAROLINA——South Carolina Public Service Authority, Peoples Bldg, Charleston, contracted Central Engrg Co, Davenport, Iowa, for construction of lock, west power dam and hydroelectric plant sub-structure for Santee-Cooper River project, at $4,172,380. Equipment awards will be made under separate contracts. Harza Co, 27 Cumberland St, Charleston, consulting engineer.

TENNESSEE——Fayetteville awarded contract for service-building in connection with the municipal electric distribution system to the Hamilton Const Co of Fayetteville at $29,027.

B F Goodrich Co, Akron, Ohio, plans steam power plant for central-heating and processing at branch mill at Clarksville, for production of mechanical rubber goods. Plant will consist of main mill of 200,000 sq ft floor space and several auxiliary buildings. Cost estimated close to $1,500,000.

Hamilton Co, Inc, U P Bldg, Memphis, R L Irvine, district manager, plans immediate construction of new 1-story cold-storage plant at Jackson, including locker system. Cost over $40,000.

TEXAS——Atlantic Refining Co, 260 South Broad St, Philadelphia, Pa., plans natural-gasoline plant in Weslaco oil-field district, Hidalgo County, including compressor-station, boiler house, pumping-plant, steel-tank storage division, pipeline system and other facilities.

Farmers' Cooperative Assn, San Angelo, plans 1-story cold-storage and refrigerating plant, with locker system. Cost about $30,000.

Warren Petroleum Corp, National Bank of Tulsa Bldg, Tulsa, Okla., contracted Oil Well Supply Co, Tulsa, for boilers and auxiliary equipment for power house at new natural gasoline plant in Fairbanks oil field area, Harris County; also made award to Hudson Engrg Co, for cooling tower, and to Wyatt Metal & Boiler Works, for tanks, both Houston; and to Taylor Instrument Co, Rochester, N. Y., for temperature- and pressure-control in-

(Continued on page 162)

ONE

Always Stands Out!

SIZZLING drives . . . short shots . . . quick work at the net . . . in tennis the player who can *adapt* his game to different playing situations is the *one who stands out* from the rest.

This same *ability to adjust* is what makes GARLOCK 711 "Z" Packing *stand out* above other packings manufactured for similar service. Diagonal in construction, GARLOCK 711 *expands and contracts* to conform with rods that are worn, out-of-line or subject to lateral motion.

GARLOCK 711 is made of closely woven duck and a high grade rubber compound. For service against medium and low pressure steam, hot or cold water and ammonia. All sizes from ¼" to 1½".

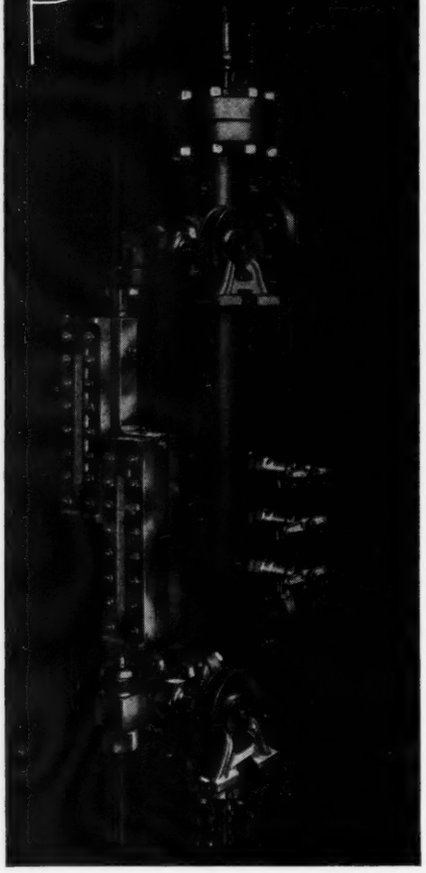
THE GARLOCK PACKING CO.
PALMYRA, NEW YORK

In Canada: The Garlock Packing Company of Canada Limited, Montreal, Que.

GARLOCK 711

GARLOCK 711—Spiral
GARLOCK 712—Rings

POSITIVE
Protection



Yarway's unique Hi-Lo Alarm mechanism utilizes balanced *solid weights* that are as indestructible and unchanging as the metal itself. Operating on the displacement principle, they literally "weigh the water level."

When the high or low water emergency occurs—instant, positive, powerful, hair-trigger *action* results—giving warning of danger by whistle, light, or both.

Yarway Water Columns, eight standard models, iron bodies with screwed connections for pressures up to 250 lbs., forged steel bodies with flanged connections for pressures up to 1500 lbs., are fully described in Catalog WG-1806. Write for a copy and working model.

YARNALL-WARING COMPANY
100 Mermaid Ave. Philadelphia

YARWAY
FLOATLESS HI-LO ALARM
WATER COLUMN

struments. New plant will cost close to $250,000.

Quartermaster, William Beaumont General Hospital, El Paso, will award contracts soon for two 2500-sq-ft and two 1500-sq-ft watertube boilers, for power house at institution.

Hamilton Hotel Co, Frost Bank Bldg, San Antonio, contracted William Ebert, 1026 West Ashby St, for installation of air-conditioning plant and system in Hamilton Hotel, at $17,651.

American National Aircraft Corp, Trinity Life Bldg, Fort Worth, A F Barrett, president, recently organized, plans immediate erection of plant in Mayfield Park district, San Antonio, for production of military airplanes and parts. Boiler house will be built. Cost about $200,000.

Panhandle Refining Co, Wichita Falls, plans 4-in. welded-steel pipeline from local pumping station to connection with main system, about 26 miles, for crude-oil transmission. Cost over $125,000 with booster stations and operating facilities.

VERMONT——Construction Service, Veterans' Administration, Washington, D. C., will receive bids until June 6 for boiler plant at institution at White River Junction, including boiler units and complete auxiliary equipment.

Burlington has been authorized by state legislature to purchase or construct municipal electric power and gas plant.

VIRGINIA——Virginia State Library Commission, State Capitol Bldg, Richmond has low bid at $43,858 from H S Flournoy, 3904 Park Ave, Richmond, for boilers, stokers and equipment for central power house at State Library Bldg, and will make award soon. Carneal, Johnston & Wright, Atlantic Life Bldg, Richmond, architects.

Appalachian Electric Power Co, Richmond, will spend approximately $7,000,000 for hydroelectric plant on New River, in Pulaski County, above Radford. Dam will be 110 ft high, and will develop approximately 110,000 hp.

WASHINGTON——Samuel Dugan, Centralia, plans cold-storage and refrigeration plant at 801 West Main St, 70 x 120 ft, with locker system. Cost reported about $35,000.

Olympus Packing Co, Hoquiam, contracted Western Machinery Exchange, Aberdeen, for boiler units for power house at local fish-packing plant. Entire project will cost about $85,000.

WISCONSIN——Baraboo Ice & Locker Co, Baraboo, Henry E Ringland and George M McArthur, heads, recently organized, plans cold-storage plant on Water St, to include locker system of about 500 units. Cost close to $50,000.

Oscar Mayer & Co, 910 Mayer Ave, Madison, plans addition to meat-packing plant, to be equipped as ice and cold-storage unit. Cost over $50,000. Henschien, Everds & Crombie, 59 East Van Buren St, Chicago, Ill., architects and engineers.

A Lentz Co, 1256 North 70th St, Milwaukee, plans improvements in power house at millwork plant, including boiler unit. Estimates being made. C A Cahill & Sons, 724 East Mason St, engineers.

Bd of Rock County Commissioners, Janesville, will take bids soon for improvements in power house near city, including boiler, and pumping units. Financing has been arranged through Federal aid. Bradley & Bradley, 226 South Main St, Rockford, Ill., architects.

Pauly & Pauly Cheese Co, Manitowoc, plans improvements in boiler plant at food products factory, including installation of additional equipment. Cost reported close to $25,000.

Kimberly-Clark Corp, Neenah, contracted James Leck Co, 211 South 11th St, Minneapolis, Minn., for power house, 61 x 90 ft, and 80 ft high, at branch pulp and paper-mill at Niagara. Cost close to $175,000 with boiler units.

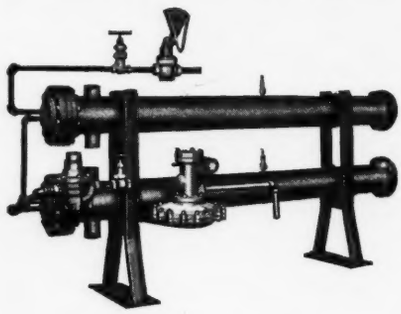
Superior Housing Authority, Superior, John Meyett, secretary, plans central-heating plant at housing development, for which financing of $675,000 has been arranged through Federal aid.

Bd of Sheboygan County Commissioners, Sheboygan, plans central-heating plant, 60 x 90 ft, for county buildings. Cost reported close to $50,000, with boilers, stokers and accessories. A E Stubenrauch, 809 North 8th St, architect.

Kieckhefer Container Co, 1715 West Canal St, Milwaukee, plans boiler house, 40 x 40 ft, at branch plant on South 18th St, Manitowoc, for production of corrugated containers. Award made to Cleaver-Brooks Co, Milwaukee, for oil-fired boiler unit and contracts for other equipment will be made soon. Entire project will cost about $125,000.

WYOMING——Union Pacific Coal Co, Rock Springs, is considering improve-

There is no
MYSTERY
to HENSZEY
Continuous Blowdown



Here's what it is . . .

The Henszey Continuous Blowdown system consists mainly of either a two stage temperature exchanger or a combination of flash tank and low temperature exchanger—a Flow Indicator—a Blowdown Meter, and a Proportioning Valve.

Here's what it does . . .

This remarkable system eliminates scale, priming, foaming, and carry-over, by simply drawing off the accumulated impurities at a rate that keeps the boiler water concentration at a pre-determined proper degree. This is done continuously, automatically and *without heat loss!*

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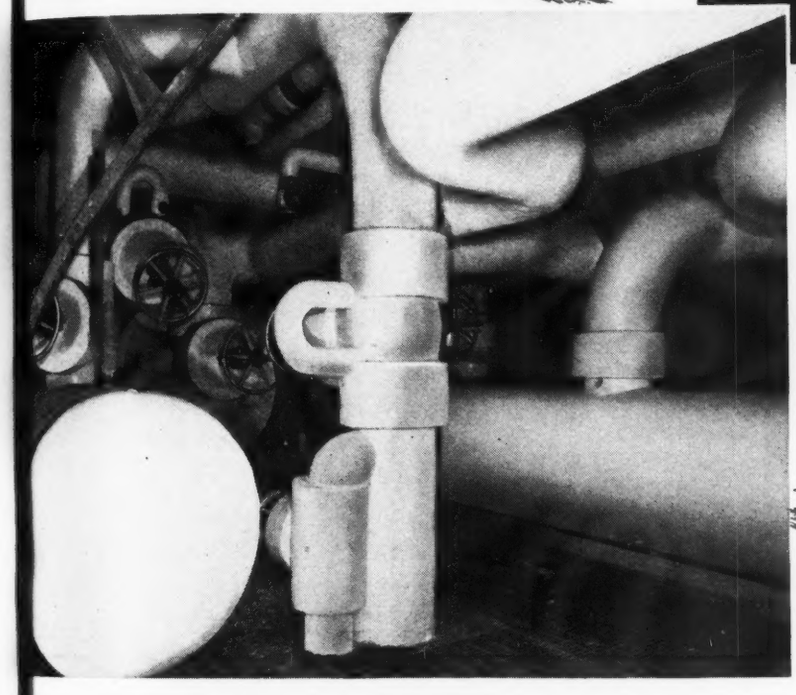
BOILER WATER CONCENTRATION CONTROL SYSTEMS

GREATER SKILL *here*



CUTS COSTS *here*

Modern piping systems with their numerous auxiliary equipment valves, etc. place more and more emphasis on piping fabrication that can comply with stringent specifications.

Pittsburgh Piping is not content to have adequate shop facilities for accurately pre-fabricating large sub-assemblies in order to simplify field erection. It has done intensive research in developing and perfecting new fabricating techniques that have made possible meeting specifications for more efficient systems.

When you are planning an extension or an entirely new piping system, it is well to remember that Pittsburgh Piping has the skill and the facilities required for accurate, efficient pre-fabrication and erection of every type of piping.

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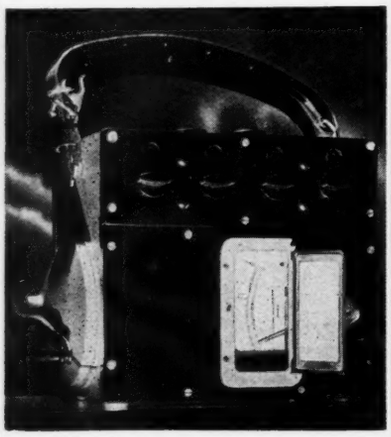
Pittsburgh Piping

"MEGGER"



"Bridge-Meg" Resistance Tester. A combined "Megger" Insulation Tester and Wheatstone Bridge—a complete resistance measuring outfit.

"....Have Saved Hundreds of Dollars"

The Chief Electrician of an industrial plant in California is responsible for the operation of over 500 motors, ranging from 1 to 800 hp., —in use 24 hours per day. If insulation fails, there is *trouble*. And trouble costs money.

About three years ago, upon advice of a Consulting Engineer, they purchased a "Bridge-Meg" Resistance Tester. "We used to guess at insulation" says the Chief Electrician, "now our 'Megger' Tester tells us just what we want to know, and we have saved *hundreds of dollars*."

They follow the simple and practical "Megger" Test Record system, which gives them a "case history" for the insulation of each motor. And since the "Megger" instrument is of the "Bridge-Meg" type, it never fails to help them locate trouble after it is detected.

Write for Bulletin 1615-P just issued, describing the "Bridge-Meg" Resistance Tester.

JAMES G. BIDDLE CO.

ELECTRICAL INSTRUMENTS

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Other Biddle Specialties:

"Megger" Ground Testing Instruments
"Megger" Capacitance Meter
"Megger" Direct-Reading Ohmmeters
"Ducter" Low Resistance Testing Sets
"Dionic" Water Tester
"Frahm" Vibrating-Reed Tachometers and Frequency Meters
"Jagabi" Rheostats
"Jagabi" Speed-Measuring Instruments

ments in power plant at mining properties, with 7500-kw turbine-generator unit and two boilers. Work scheduled to begin in fall. Eugene McAuliffe, president.

MISCELLANEOUS——Bureau of Yards and Docks, Navy Dept, Washington, D. C., plans construction of power plants, fuel-oil storage and distributing-tanks and systems, water-supply systems, electrical and other utilities at group of naval stations, including Pearl Harbor and Kaneohe, Hawaiian Islands; Sitka and Kodiak, Alaska; Midway Island, Wake Island, Palmyra Island, Johnston Island; San Juan, Puerto Rico; Pensacola, Fla; and Tongue Point, Astoria, Ore. Total appropriation of $65,000,000 is being arranged for this work at different points noted.

Current Comment

A Discussion of Reciprocal Buying

AS AN operating engineer who has worked in a large industrial organization that is afflicted with the disease of reciprocal buying, I am in hearty accord with J. F. Lincoln's views, page 108, February POWER, concerning the evils of this practice.

What can be more disheartening to a man responsible for costs in a power or maintenance department than to have the results of many years effort toward securing a reasonable degree of equipment standardization completely upset by the influx of assorted replacements that, while performing the same functions as the standardized machines, are radically different in design and have no sound engineering or economic basis for their purchase other than reciprocity?

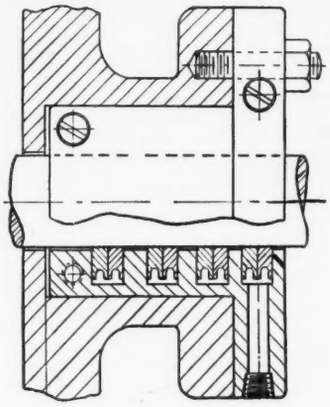
When because of these oddities scattered hither and yon throughout the plant, spare-parts inventories must necessarily be increased and cost of maintenance has a tendency to rise, what can he do in the face of the all inclusive answer, "It's company policy," but lie down and take it?

And what about the requisitions that start out after a certain item, designed in such a way, by a particular manufacturer to do a given job better than similar devices put on the market by his competitors? Such requisitions are often issued only after hours of engineering shopping, weighing advantages and comparing adaptabilities, and represent a great deal more than the actual monetary sum indicated in the price column.

In former years getting such an order past the purchasing agent was a big problem, but in this enlightened age should require no more than a few words of explanation. So far so good, but what happens next? The item arrives and when examined is found to be something remotely similar to the device ordered but entirely unsuitable for the job at hand. Then interdepartmental correspondence must start and after a waste of many times the value of the device, the engineer may some day secure what he needs. All this delay and expense because of a purchasing system based on reciprocal agreements and the inflexibility of misguided company policy.

It is my personal opinion, however, that these and other evils of reciprocal buying must be eliminated by industry alone and that, since the practice itself is nothing

FRANCE
Metal Packing



"Full-floating" rings in metal cases make a snug seal and compensate for rod deflection or misalignment—the ideal metal packing for piston rods and valve stems in any type of engine, pump or compressor, whether the motion is reciprocating or oscillating.

...Wears as long as any other working part of the engine

Scientific design and simple construction—for steam, air, gas and crankcase oil service under any condition of speed, pressure or temperature.

Maximum sealing efficiency.

Prevents rod scoring.

Used for years . . . the world over.

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Satisfaction Guaranteed

Original FRANCE METAL PACKING

You're Rid of High Handling Costs . . .

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MANHATTAN CONVEYOR BELTS

Manhattan Conveyor Belt, 48-inch, 8-ply with 3/16" x 1/16" covers, on slope conveyor in recently mechanized mine. Belt is 1830 feet long.

NO matter what the load—coal, ore, sand, gravel, cement—or how it travels—up, down, on the level, put Manhattan Conveyor Belts on the job and down go handling costs.

That's been proved . . . by the International Conveyor Belt that handled 7,873,967 tons of run-of-mine coal at a belt cost of $.00022 per ton . . . by the Super-Master Conveyor Belt that handled 5,682,149 tons of gold ore in less than five years*. . . and by hundreds of other Manhattan-made Belts handling all kinds of loads on short or long hauls and high or low lifts.

You, too, can have this high tonnage, low cost performance with a Manhattan Conveyor Belt. Let Manhattan's engineers help you select "the right belt for your job" to give trouble-free service throughout its long life.

*A section of this belt after running is now used as a sorting belt and is still in good condition after 18 months' service.

Condor PRODUCTS

- Conveyor and Elevator Belt
- Transmission Belt
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- Contractors Hose
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- Oil and Gasoline Hose
- Sand Blast Hose
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THE MANHATTAN RUBBER MFG. DIVISION
OF RAYBESTOS-MANHATTAN, INC.
EXECUTIVE OFFICES AND FACTORIES
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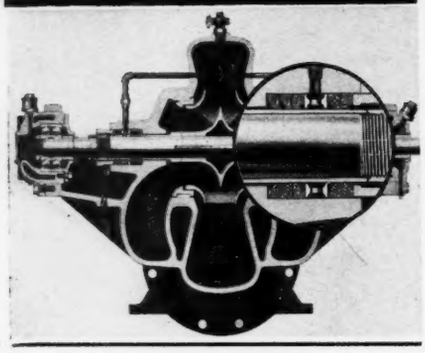
For Centrifugal Pumps — Sea-Ro Nek-Seal* Packing!



Sea-Ro Nek-Seal No. 501-C. Installed in Worthington Type LA Centrifugal Pump.

● Sea-Ro Nek-Seal Packing Rings No. 501-C are specifically designed for Centrifugal and Rotary Pump service. They eliminate packing trouble at its source—in stuffing box clearance spaces.

● Because of its patented construction, Nek-Seal cannot crowd through the gland. High speeds and high temperatures will not affect its sealing ability. Nek-Seal gives you *permanent* sealing without friction.

● Unlike ordinary packing, Nek-Seal does not vulcanize or carbonize in the stuffing box. This means long life for both pump and packing because scoring and pitting of the shaft are eliminated.

● Check up on Sea-Ro No. 501-C —Investigate its possibilities for your own high pressure Centrifugal and Rotary equipment. You may find it to be the answer to your packing problem.

*Reg. U. S. Pat. Off.

Sea-Ro Packing Company
75 West Street, New York, N.Y.

SEA-RO

more than a reversion to primitive barter, government can have nothing to do with the matter, unless, as is sometimes the case, it becomes mixed up in or with monopolistic practices. Just as in old fashioned horse trading, this modern method of doing business will always result in someone getting stuck and when enough business men realize the fact, it will die of its own accord.

Roanoke, Va. H T RALEIGH

An Answer

IN APRIL, under the heading "Just a Mechanic" in my editorial, I cut loose on a subject close to my heart. I glorified the good mechanic and made some rather uncomplimentary remarks about those who associate "lily-white" hands with a superior intellectual status.

Here's the comeback, from a good friend who feels that I gave the intellectual side of engineering a pretty bad break:

"I think it must have been 'the lily-fingered dandies' that stirred up the desire for battle, and perhaps the hint that the white collars look down on mechanics solely because they are mechanics and because they choose to be no greater than mechanics.

"What is wrong? Not that you say 'be always a mechanic if you would call yourself an engineer', but rather that you imply that mastery of mechanic's tools automatically makes one an 'engineer' and that love of more abstract tools means certain classification as a lily-fingered dandy. That may not be what you mean, but that is what one reader, me, got. And I rise to maintain that your implication is in error—not to break your philosophy, but to bend it a bit.

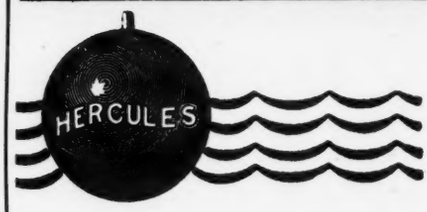
"First, let me qualify as a critic. I have on a white shirt, bow tie and my shoes are shined. Doesn't that make me the opposite of the 'horny-handed son of toil'? But my fingernails have not yet lost the carbon that goes with cleaning the gizzard of a prime mover.

"And second, let's see if you qualify. How's your score on these ten samples of everyday 'engineer's' dirty work, the kind of a thing a 'mechanic' does in the power plant: Have you ever (1) packed a pump gland, (2) fitted a bearing, (3) shot a condenser plug, (4) held a slice bar, (5) made up a live cable joint, (6) cleaned an oil tank, (7) tapped a rivet, (8) grouted a bed plate, (9) made a pipe hanger, (10) listened for a turbine rub.

"If you don't score over 70%, maybe you should come out and admit that there is no single road to being an engineer. Let each man select his tools and his road without inciting any to scorn. I admire skill in handling vectors equally with making a truly formed die, proficiency in a heat-transfer problem with accurate chucking.

"Engineering, by definition, is any useful application of knowledge for the betterment of mankind. Aren't we narrow when we say it has to be done with the hands? Isn't there a place for some mental construction? Don't we need mathematics as well as a file, calculus sometimes instead of a $\frac{15}{16}$-in. reamer?

HERCULES
Seamless Copper
FLOATS



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Fabricated of seamless copper under our special spinning process, Hercules Floats are uniform in thickness and high in mechanical strength.

You can depend on Hercules for floats—in standard shapes up to 10 in. and in special types to your specifications—to give long, dependable, economical service.

Insure care-free maintenance of water level in your heaters, tanks, reservoirs and other equipment by specifying "HERCULES."

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Save Air—Save Dollars
ROCKWELL
BLAST GATES

Threaded Slide Type

Flanged Slide Type

For Low Pressure Air

●

Slide Type
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50 CHURCH ST., NEW YORK

A Basically Different Lubricating Oil Removes Carbon; *has* Stronger Natural Film

LION *Naturalube*

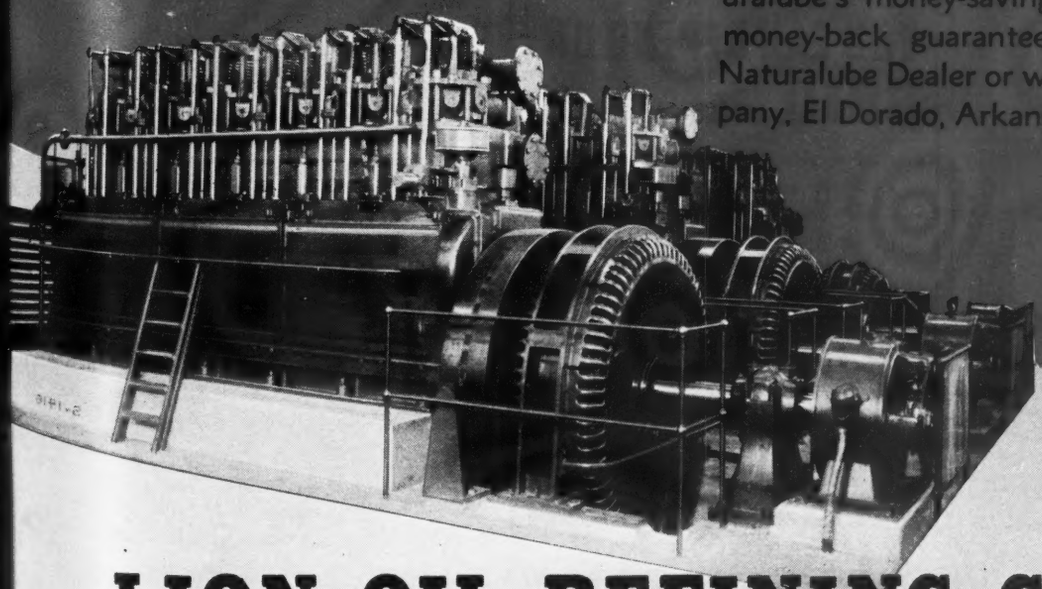
MOTOR OIL AND DIESEL ENGINE OIL

Ability of New Type Oil to Remove Carbon Restores Power—Stronger Natural Film Saves Wear

Internal combustion engines deliver more power at less costs when lubricated with Lion Naturalube. Basically different from conventional type oils, Naturalube is naturally fitted for the hardest lubrication job where long continuous service and rock bottom economy are required.

Naturalube's outstanding properties: a stronger natural protective film and the ability to remove hard carbon from pistons, rings, valves and spark plugs, insure longer periods of continuous economical engine operation. Operators of all types of internal combustion engines testify that Naturalube conserves power, and lowers fuel and maintenance costs. In comparative laboratory wear tests 33 1/3% to 116% more wear occurred when using other type oils than when using Naturalube.

For visible and understandable proof of Naturalube's money-saving properties and details of money-back guarantee, phone the nearest Lion Naturalube Dealer or write Lion Oil Refining Company, El Dorado, Arkansas.



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PENFLEX EXHAUST PIPES for Flexible Safety

Sizes to 14"

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4-WALL interlocking joint construction, with asbestos packing, relieves thermal strains due to cold starts and shut-downs. By stopping vibration at exhaust manifolds, damage to engine parts is prevented.

Air Jacket Stays Hand Cool

Addition of outer tubing provides effective insulation, at same time acting as a ventilating chimney. With 3/8" extensibility for every foot, Penflex Exhausts form into easy bends without the use of special tools. Try out any size to 14".

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H.P. Steam Hose in bronze or steel
Heatproof Couplings
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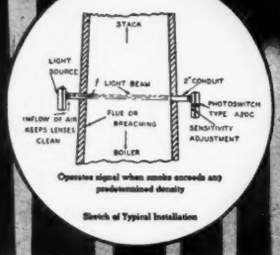
INCREASES FUEL ECONOMY—AVOIDS SMOKE NUISANCE



Operates signal when smoke exceeds any predetermined density

Sketch of Typical Installation

DEPENDABLE—RUGGED
• GUARANTEED •

SOLVES YOUR OTHER CONTROL PROBLEMS

Wherever objects are counted, electrical machinery automatically controlled, or warning signals are used, PHOTOSWITCH will do the job better and more economically.

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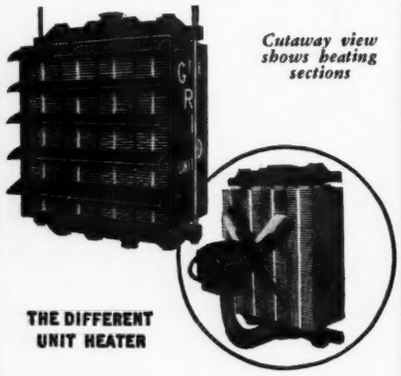

Cutaway view shows heating sections

THE DIFFERENT UNIT HEATER

YOU CAN DEPEND ON GRID UNIT HEATERS

. . . No electrolysis
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. . . Long life of unit

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GRID
UNIT HEATER

"None of us uses every tool every day. Because the need is not frequent, does not always mean it is not important. True that only a few of us can use a mathematical operator, but many can be familiar with a welding torch. A Steinmetz neither expresses nor feels scorn for an armature winder—need the latter criticize the soft hands of the former?

"You are right when you counsel a college graduate to know the feel of cutting oil. And likewise the machinist could well investigate logarithms. But shouldn't you say that every man is broader for a wider acquaintance with the other fellow's job? That we can never learn too much? That each man should do what he loves best to do, but study the other fellow's point of view too, and learn to value him as another efficient cog in the machine age?—T.A.S."

Fair enough, T.A.S.! I, too, admire skill in handling vectors and heat-transfer problems. The world needs calculus and mathematics a lot—perhaps as much as files and reamers. I'll even admit that a Steinmetz and an Einstein have no great need for practical shop experience.

Coming down from these heights to the levels on which most engineers must work, it still can be proved that certain trained theorists have made great contributions without practical mechanical background. It is also a fact that a practical mechanic may accomplish great things without benefit of theory.

A point I want to make is that the engineer who is not a good mechanic is crippled, exactly as the average mechanic is crippled because he can't use cosines and a slide rule. Each would be more effective if he had some of the other fellow's skill without losing anything he already possesses.

My editorial was a sincere expression of alarm because some of our engineers seem to feel that first-hand contact with machines is not necessary or even desirable if one has ample skill with pencil and paper. Mind you, I don't prescribe less paper and fewer pencils—merely more contact with machines.

Even worse is the state of the practical men who are not practical enough to study the theory behind their daily work, the men who rap car wheels for a lifetime without bothering to ask why.—PHIL SWAIN.

INDUSTRY, *economy, honesty and kindness form a quartet of virtues that will never be improved upon.*—James Oliver

DIE *when I may, I want it said of me by those who knew me best, that I always plucked a thistle and planted a flower where I thought a flower would grow.*—Abraham Lincoln

MY *son Hannibal will be a great general, because of all my soldiers he best knows how to obey.*—Hamilcar

LET *us endeavor so to live that when we come to die, even the undertaker will be sorry.*—Mark Twain